The Journal of the American Association of Nurse Anesthetists

IN THIS ISSUE

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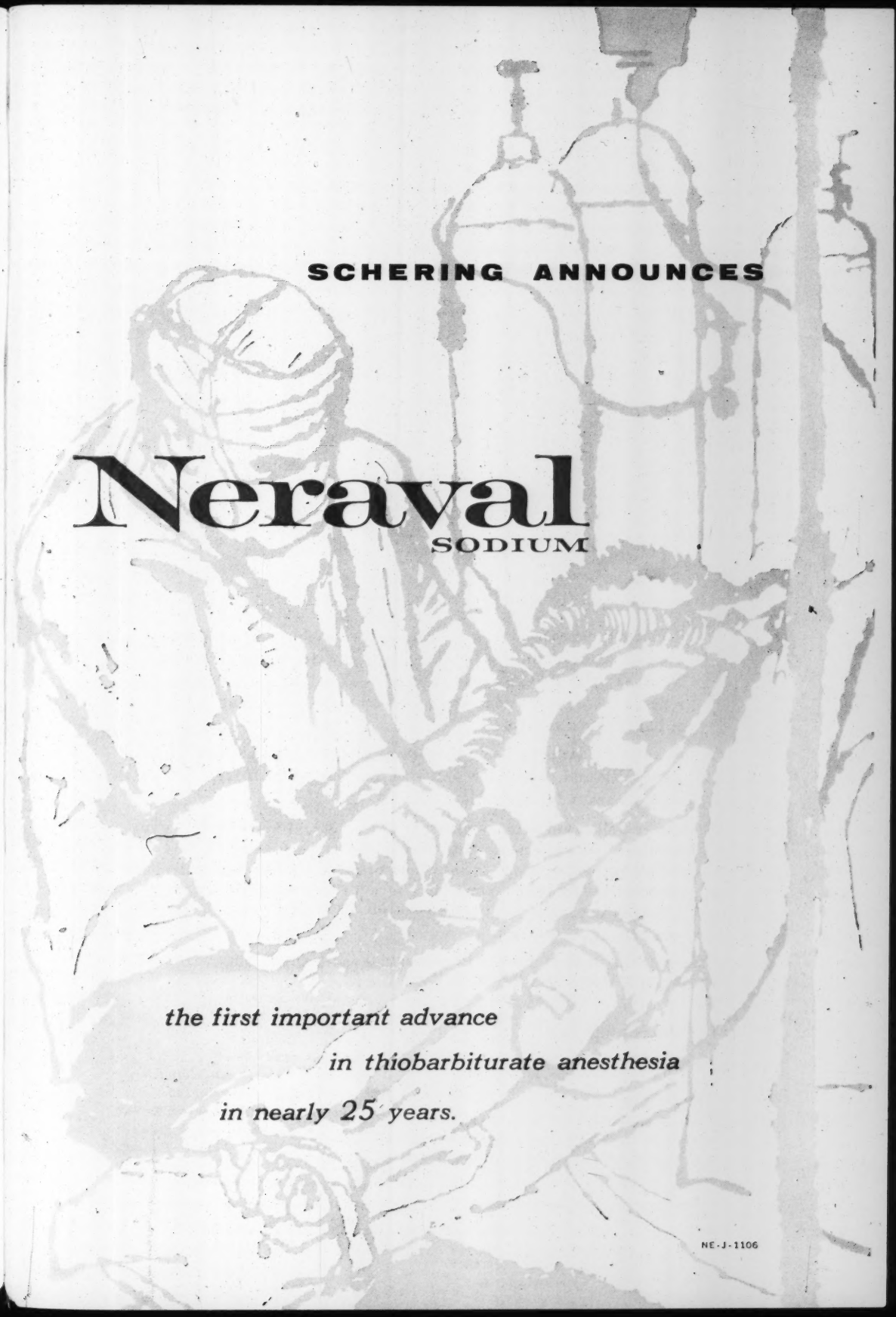
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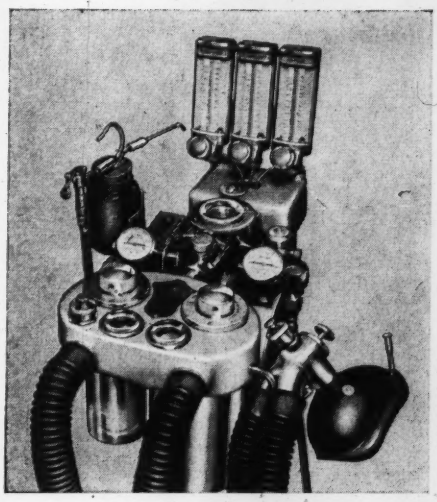

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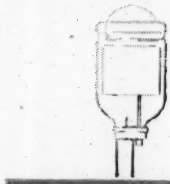

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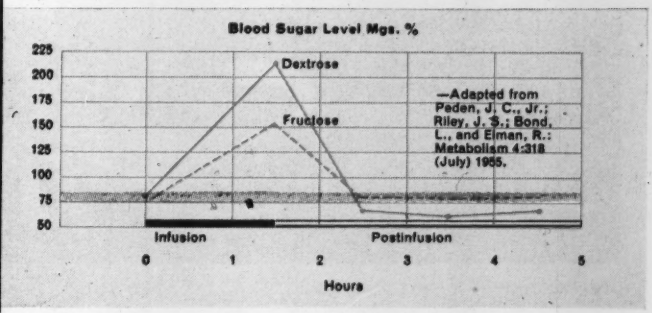

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Legal Aspects of Anesthesia Administration by Nurses

Emanuel Hayt, LLB., Counsel A.A.N.A.
New York

The use of ether anesthesia began about 100 years ago. Before the use of ether, operations were performed under the influence of narcotics, sedatives, alcoholic potions, and many without any provision for the abolition of pain.

In the early days of ether the administration was simplicity itself. A mask was made of a towel folded upon a newspaper in the shape of a cone, and into this receptacle a small quantity of ether was poured, and the cone placed over the nose and mouth of the patient. It was held snugly in place while the patient, struggling to overcome the vapors of ether and carbon dioxide, finally reached an unconscious state. Then the mask or cone was removed at intervals and more ether added as indicated.

There were few changes in this procedure until the nineties, when the "open method" was introduced. This consisted of a small wire frame, covered with a layer or two of heavy cotton cloth, upon which ether was dropped almost continuously. In the meantime chloroform appeared and was popular for many years, but it became apparent that its advantages were outweighed by its disadvantages, and it is rarely used at present.

At the turn of the century anesthesia came into its own. Nitrous oxide was added to eliminate the stage of excitement which commonly attended ether anesthesia. Ethylene (1923) and cyclopropane (1933) entered the field clinically. New masks or inhalers were devised to mix and measure anesthetic agents. Novocaine was discovered in 1904. Labat popularized regional and spinal anesthesia in 1920. Veronal, the first barbiturate, was introduced in 1903; pentothal, the most widely used barbiturate, was introduced in 1934, and curare in 1941.

The last decade has seen the refinement of the anesthetic apparatus, the perfection of the endotracheal administration, and the efficient methods of resuscitation in respiratory and cardiac arrest. It has made it possible for surgery to enter new domains, especially the pulmonary and circulatory systems, with comparative safety for the patient.[1]

1. LEGALITY OF ADMINISTRATION BY NURSES

Advances in science and technology have expanded the functions of nurses; basal metabolism tests, intravenous injections and anesthesia administration, as well as other diag-

1. White, Charles S., M.D., "A Century of Anesthesia", Medical Annals of the District of Columbia, 4:191-192, 1955.

nostic and therapeutic procedures, once performed entirely by physicians, are now done also by nurses or technicians. To administer anesthetics competently the nurse must have the necessary training.

The American College of Surgeons, recognizing that it is not always possible for the small hospital to have the services of an anesthesiologist available, has declared that nurse anesthetists who have specialized in the administration of anesthetics are acceptable for the work, but since they are not physicians licensed to administer drugs they should be under medical supervision.

The Commissioners of the Joint Commission on Accreditation of Hospitals recognize that the practice of giving anesthetics by qualified nurse anesthetists in hospitals has been going on in this and other countries for many years and that nurse anesthetists have given excellent service and help to the medical profession and hospitals. Under no circumstances will any hospital utilizing the services of a nurse anesthetist be criticized by the Joint Commission, provided that:

1. The nurse anesthetist is qualified by training and experience to give anesthetics and that these qualifications have been carefully investigated by the appropriate authorities in the hospital.

2. The nurse anesthetist is under the direction and supervision of the operating surgeon at all times.[2]

The nurse anesthetist is not qualified to vary routines or to make the necessary medical judgments. She is under the direction of the operating surgeon. Much of the technical management of resuscitation and inhalation therapy of a routine character can be performed by carefully instructed and closely supervised nurse technicians.[3]

Qualifications of Nurse Anesthetist

A nurse may become a qualified anesthetist only after her nursing training and experience have been supplemented by theoretical and clinical training in a school of anesthesia. She must be a graduate registered nurse before being admitted to an accredited school of anesthesia. After completion of the prescribed course, she must pass a qualifying examination for membership in the American Association of Nurse Anesthetists.

A working knowledge of anatomy and physiology, knowing the reactions of the body during any type of anesthesia, and familiarity with the signs and symptoms of shock are part of her training.

Anesthesia Administration and Medical Practice

One objection sometimes raised to anesthesia administration by a nurse is that she practices medicine; that a license as a registered nurse does not authorize her to practice medicine, since nursing is confined to the performance of professional services in carrying out treatments prescribed by a licensed physician.

The practice of medicine consists of three things: first, in judging the nature, character and symptoms of the disease; second, in determining the proper remedy for the disease; third, in giving or prescribing a remedy for the disease. If the person who makes the diagnosis also pre-

2. "Accreditation Problems," Kenneth B. Babcock, M.D., **Hosp.**, 30:20, Aug. 16, 1956.

3. Flagg, P.J., M.D., "The Role of the Consulting Pneumatologist", **Mod. Hosp.**, 74:100, May, 1950.

scribes the medicine for the patient, he is practicing medicine,[4] but the mere giving of medicine prescribed by the physician in charge who has made a diagnosis and who directs the manner, the time and character of of the medicine to be administered, has never been considered the practise of medicine. By the same token, a nurse administering a prescribed anesthetic to a patient in the presence of and in accordance with the directions of the surgeon in charge does not practice medicine within the meaning of the term.[5]

There is an indication in the court decisions, although there is no unanimity of opinion, that a considerable group of practitioners of medicine are of the opinion that the administration of anesthesia by a licensed nurse is a duty incident to the practice of medicine. Absent any direct authority on the question in the jurisdiction, it resolves itself into a strictly fact question, the answer to which can be supplied accurately only by the testimony of qualified expert witnesses.

Legal Decisions on Nurse Anesthesia

Cases indicate that the administration of anesthesia by a registered nurse may be legal either by a specific statute which authorizes that function by a nurse or because the medical practice act or the nurse practice act of the state permits it as an implied nursing service under the direction and supervision of a licensed physician.

In a California case, two surgeons who objected to the administration of anesthesia by a nurse sued to restrain a registered nurse employed by a hospital from administering general anesthetics, claiming that such procedure constituted the practice of medicine. At the trial it was shown to be the recognized procedure in hospitals for nurses to administer anesthetics under the immediate direction and supervision of the operating surgeon. Nurses in the surgery, declared the court, in preparing for and during the progress of an operation, are not diagnosing or prescribing; they are merely carrying out the orders of the physicians to whose authority they are subject. In so holding the court said: "The findings, which are amply supported by the testimony in this case, show conclusively that everything which was done by the nurse, Dagmar A. Nelson, in the present instance, and by nurses generally, in the administration of anesthetics, was and is done under the immediate direction and supervision of the operating surgeon and his assistants. Such method seems to be the uniform practice in operating rooms. There was much testimony as to the recognized practice of permitting nurses to administer anesthetics and hypodermics. One of the plaintiff's witnesses testified to what seems to be the established and uniformly accepted practice and procedure followed by surgeons and nurses and that is, that it is not diagnosing nor prescribing by the nurses within the meaning of the Medical Practice Act. We are led further to accept this practice and procedure as established when we consider the evidence of the many surgeons who supported the contention of the defendant nurse, and whose qualifications to testify concerning the practice of medicine in this community and elsewhere were established beyond dispute."[6]

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4. Underwood v. Scott, 43 Kan. 714, 23 P. 942.

5. Frank v. South, 175 Ky. 417, 194 S.W. 375.

6. Chalmers-Francis v. Nelson, 57 P. 2d 1312 (Cal.)

A surgeon in Kentucky sought to have his licensed nurse permitted to give anesthesia to his patients. She had more than six years' nursing experience, had made a special study of anesthesia, and had administered anesthetics to more than 1,200 patients. In each case, the surgeon had selected the anesthetic and supervised its administration. The court concluded that the nurse was not practicing medicine, but was exercising her profession within its proper limits. "The mere giving of medicines prescribed by a physician in charge who has made a diagnosis, determined the remedy and directed the manner and time and the character of the medicines to be administered, has never been considered the practice of medicine. The person who administers medicine under such a state of case does not exercise any judgment as to the character of the disease nor the necessary remedy nor the manner in which, nor when the medicine should be administered, but merely acts as the hands of the physician in administering the medicines in the quantities and at the times directed by the physician. It having been agreed that the nurse has never prescribed for any person, nor treated any human ailment or infirmity unless the administration of anesthetics to a patient undergoing or preparing to undergo a surgical operation, and in the presence and in accordance with the directions of the surgeon in charge, who prescribed the anesthetic to be administered, it would seem that she is not engaged in the practice of medicine within the meaning of that term in accordance with its popular sense."[7]

In a West Virginia case, the court held, in an action for malpractice based on the administration of an anesthetic by a nurse, that it was error to permit an expert witness to testify that in his opinion the administration of ether by a doctor of medicine is legally required, because neither the common law nor any of the statutes of that state required such method of administration.[8]

The charges of a dentist in Michigan for the administration of cocaine, morphine and other drugs for an incurable cancer of the mouth were objected to on the ground that he was not legally qualified to practice medicine. Since the dentist had administered anesthetic drugs and treated the cancer under the instructions of a licensed physician, the court said he functioned as an ordinary nurse and could recover for his services.[9]

Suit was brought by an Arizona dentist to have a declaration made by the court as to his right to employ a registered nurse, who had taken a prescribed course in anesthesia at a hospital in good standing, to administer anesthetics to his patients under his direction and in his immediate presence. The state statute provided that a registered nurse may administer anesthetics under the direction, and in the immediate presence, of a licensed physician or surgeon, provided that such nurse had taken a prescribed course in anesthesia at a hospital in good standing, or is a graduate in the science of anesthesia administration from some recognized school or college. Since dentists were permitted by law to use anesthetics,

7. Frank v. South, 175 Ky. 417, 194 S.W 375.

8. Cook v. Coleman, 11 S.E. 750 (W. Va.)

9. In re Carpenter's Estate, 196 Mich. 561, 162 N.W. 963.

the court held that the term surgeon applied both to physicians and "dental surgeons" and that qualified nurses, therefore, could act under their direction.[10]

Opinions of the Attorneys-General

In addition to court decisions in some states upholding the legality of anesthesia administration by nurses, there are a number of opinions rendered by state attorneys-general. An attorney general is the chief law officer of the state, to whom is entrusted not only the duty of prosecuting or defending all suits or proceedings wherein the state is concerned, but also the task of advising the chief executive and other administrative officers in matters on which they may desire his opinion. In the performance of his official duties, the opinions and recommendations given by the attorney general are entitled to the greatest respect, but are not binding upon the courts.

The Attorney General of Iowa has held that it is not illegal for a registered nurse to give anesthesia under the direction of a licensed physician. The adminstration of anesthesia by a licensed nurse, under the supervision and direction of a licensed physician, he states, constitutes the practice of nursing and not the practice of medicine. There is no specific provision in the Iowa statutes requiring that a license of any type be held by a person administering anesthesia.[11]

An opinion rendered by the Attorney General of New York State holds that a nurse under the direction of a physician may administer anesthesia. He said that according to usage, the nurse administers various types of therapeutic treatment under the direction of a physician. The administration of medicines, the application of prescribed treatment, the giving of hypodermic injections and many other duties of importance are among the acts commonly performed by the nurse under the physician's direction. The administration of anesthesia falls within the same category. If done under the direction of a physician, such act on the part of the nurse does not involve a violation of law.[12]

2. LEGAL RESPONSIBILITY FOR ANESTHESIA

Generally speaking, the nurse anesthetist who merely administers an anesthetic to a patient is not liable for the negligence of the operating surgeon.[13] It is the duty of the nurse anesthetist to watch the patient's color, pulse, respiration, reflexes and the flow and color of the blood, for no matter how far science may have advanced, the anesthetist must always be alert and vigilant during the operative procedure. The greatest skill will serve the anesthetist naught if she relaxes her vigilance at any time.

The physical condition of the patient prior to anesthesia should be fully known to the nurse anesthetist and the report of the preoperative examination should include heart, lungs, blood pressure readings, hemoglobin estimation and urinalysis, as well as previous surgical procedures, recent colds, shortness of breath and habits of life. If there is evidence of a condition making anesthesia diffi-

10. State v. Borah, 76 P. 2d 757 (Ariz.)

11. Report of Attorney General of Iowa on Registered Nurses: Administration of Anesthetics, June 27, 1946.

12. Opinion of Attorney General of New York State, Nov. 15, 1933.

13. Robinson v. Crotwell, 175 Ala. 194, 57 So. 23,

cult or hazardous, the nurse anesthetist should know this. The nurse anesthetist should not ordinarily administer an anesthetic in an emergency without an examination of the heart, lungs, blood pressure and urine by some member of the medical staff. Before anesthesia is started, a recheck of the patient's clinical condition should be made in order to eliminate unforeseen hazards.

Personal Liability of Nurse Anesthetist

The nurse anesthetist, like any other member of the surgical team, may become personally liable for her own negligence, irrespective of whether the surgeon may be jointly or primarily liable. The fact that the court may consider the nurse an agent of the hospital under the rule of respondeat superior does not relieve her of responsibility for her own carelessness.

During an operation, gauze was placed in the uterus, but it was not removed at the termination of the operation. The nurse was sued along with the surgeon. No liability attached to the nurse anesthetist, because in surgical operations she is directly chargeable with the physical condition of the patient; her attention must be directed to the task of administering the proper amount of the anesthetic and continuing to supply it in just such proportions as will insure the patient remaining in a comatose condition while the operation is being performed.[14]

Responsibility of Surgeon for Nurse Anesthetist

There are cases which hold that where the surgeon has full control over the actions of the nurse anesthetist in the operating room, he becomes responsible for her negligence.

The death of an eight-year old girl was caused, according to the complaint, by an overdose of an anesthetic administered by a nurse anesthetist employed by the hospital. A tonsillectomy had been performed by the surgeon; the patient was removed to her room; she died some hours later without regaining consciousness, although she was seen from time to time by the surgeon. The hospital, the surgeon, and the nurse anesthetist were joined in the lawsuit as defendants. Although the nurse anesthetist was in the general employ of the hospital, the court stated that the surgeon could be held responsible for her negligence, as he had full control over her in the operating room. When he occupies such a position, his duties and liabilities over the administration of the anesthesia are substantially the same as those respecting the other phases of the operation and his treatment of the patient generally.[15]

If the surgeon himself, rather than the hospital, selects the nurse anesthetist, he is expected to exercise the same degree of knowledge, skill and care in the choice as in the performance of any part of the operation.[16] During the course of the operation, when a patient is under anesthesia, the surgeon must see that no preventable injury occurs to him.[17] On the other hand, the surgeon has the right to assume that the nurse anesthetist employed by the hospital is competent. He is not chargeable with her

14. Jett v. Linville, 202 Ky. 198, 259 S.W. 43.

15. Jackson v. Joyner, 72 S.E. 2d 589 (N. C.)

16. Frank v. South, 175 Ky. 417, 194 S.W. 375.

17. Aderhold v. Bishop, 94 Okla. 203, 221 P. 752.

incompetence unless he is aware of her lack of experience and skill. A duty rests upon him, however, to give proper instructions to the nurse anesthetist, except as to her ordinary duties, and to control her actions in the operating room.[18]

Hospital Liability for Nurse Anesthetist

The evidence may show that the surgeon exercised no control over the nurse anesthetist and that she acted, not as his agent, but as an employee of the hospital. In such case, the courts may apply the principle of respondeat superior, which imposes liability on the employer for the negligence of the employee. In a particular case, whether the nurse anesthetist is to be regarded as the agent of the hospital or of the operating surgeon during the operation may be a question of fact for the jury.

In the course of a tonsillectomy, a nurse anesthetist employed by a hospital administered ether. As the child started to come out of the anesthetic a second time, more ether was administered. After the third increase in ether the swabbed blood appeared very dark; respiration ceased. While the surgeon applied artificial respiration the nurse went to secure a mechanical resuscitator. When she returned with it three or four minutes later, the child was dead.

Action was brought against the hospital and the two operating surgeons. The surgeons testified that lack of sufficient oxygen was the cause of death and that if the mechanical resuscitator had been available at once the child might have been saved. The autopsy report indicated the cause of death as "inspiration of hemorrhagic material" due to a stoppage of suction, which in turn was caused by the need for resuscitation. The court held that a master-servant relationship existed between the hospital and nurse anesthetist; her negligence was imputed to the hospital, on the theory of respondeat superior. The surgeons were discharged of liability.[19]

When the testimony is contradictory as to whether the nurse anesthetist was the agent of the surgeon or of the hospital, the final decision may be submitted as a question of fact for the jury. If the case is tried without a jury, the court decides both the questions of fact and of law.

A patient brought an action against the surgeon and hospital to recover damages for injuries suffered by her during the administration of an anesthetic by a nurse anesthetist. The patient's evidence indicated that she was to undergo a tonsillectomy; while the anesthetic was being administered preparatory to the operation it was noted by the nurse anesthetist that the patient's abdomen had become distended; the operation was abandoned. The anesthetic, ether and air, had somehow been forced through the nasal catheter past the lungs and into the abdominal cavity.

An action for damages for personal injuries was instituted by the patient against the surgeon who was to have performed the operation and the hospital which furnished the nurse anesthetist. The surgeon's answer to the complaint alleged that the nurse anesthetist was not his agent during the administration of the anesthetic. He also testified that the nurse anesthetist knew considerably more about administering an anesthetic than he

18. Morrison v. Henke, 165 Mis. 166, 160 N.W. 173.

19. Cavero v. Franklin General Benevolent Society, 214 P. 2d 854 (Cal.)

did, and that he left completely to her discretion the administration of the ether to the patient. Since the evidence was in conflict, the trial court submitted the question of agency to the jury, which concluded that the nurse anesthetist was not the agent of the surgeon, but that of the hospital which was her employer. The action against the surgeon was dismissed; the verdict in favor of the patient against the hospital was affirmed.[20]

3. CONSENT OF PATIENT TO USE ANESTHETICS

A patient submitting to an operation may object to the use of specific anesthetics or claim that the anesthetic was used without his express consent. An operative consent form signed by the patient which includes a specific provision for the use of "any anesthetic" is binding upon the patient.

The mother-in-law of the patient and the patient's husband stated they told the doctor to use no spinal anesthetic. This was denied by the doctor. He asserted the spinal anesthetic was necessary and proper; that it would have been inadvisable to use a general anesthetic, because the operation to remove a piece of a hypodermic needle in her thigh was to be performed under a fluoroscope; that there was danger of explosion in using inflammable general anesthetics in a room where such electrical equipment is being used; also that it was inadvisable to give a general anesthetic, because the patient had been recently operated on for appendicitis, and such anesthetics may produce nausea and vomiting which would cause distension of a fresh wound. Novocaine injected locally could not be used either, he said, because the quantity required would have so affected the tissues as to produce a sloughing in the field of operation. Since the authorization for operation procured by the hospital included a consent for the use of "any anesthetics", and as there was no proof of damage from the use of the spinal anesthetic, the complaint was dismissed.[21]

There may be disagreement as to the type of anesthetic which the patient alleges he authorized to be used. However, if the surgeon agrees to a specific anesthetic and then uses another without justification he may be violating his agreement with the patient. A mature patient's decisions in this respect are entitled to consideration over those of his near relatives.

The surgeon was sued for a breach of contract in that he gave the patient a local anesthetic, procaine, instead of a general anesthetic, ether, which the mother of the decedent alleged he had agreed to use. The 19-year-old patient just prior to the tonsillectomy asked the surgeon's assistant to use a local anesthetic. Procaine was used; the patient died at once. It was held that the mother had no cause of action; the patient was an emancipated minor, competent in all respects to decide matters for himself; he was not bound by the mother's directions and her alleged agreement with the surgeon.[22]

Unauthorized Use May Be Assault and Battery

The rule that the surgeon may select the anesthetic most suitable for the patient protects the surgeon, unless facts are proved to contraindicate the use of the particular drug.

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20. Kemalyan v. Henderson and Deaconess Hospital, 277 P. 2d 372 (Wash.)

21. Kester v. O'Neil, 59 Cal. App. 2d 428, 138 P. 2d 723.

22. Bishop v. Shurley, 211 N.W. 75 (Mich.)

A case was tried on the theory of assault by reason of the use of a method of anesthetizing objected to by the patient. The family doctor had diagnosed the patient's condition as a chronic appendix which should be removed. He referred her to a surgeon who confirmed the diagnosis. The patient asked who would administer the anesthetic and the surgeon told her it would be done by a certain anesthetist. She stated that she was afraid of a spinal block, whereupon the surgeon informed her a general anesthetic would be administered. The surgeon instructed a nurse to write on the chart that the patient did not want a spinal anesthetic. However, after the surgeon entered the operating room he discovered that the patient had been given a spinal anesthetic by the anesthetist. Although the anesthetist noted the statement in the chart of the patient's aversion to a spinal anesthetic, there was nothing in her condition which would contraindicate the use of a spinal block.

Both the surgeon and the anesthetist were sued. At the trial a medical doctor who qualified as an expert witness for the patient, was of the opinion, based upon his examination of her and a study of her hospital records and history, that the patient had sustained a puncturing of the spinal cord which had resulted in active inflammation of the cord, producing partial paralysis from the waist down, ankylosis of the hip joints, complete loss of power in the feet, shrinking of the legs, and migraine headaches.

The court held that the surgeon was not liable, because his agreement with the patient that she would not be given a spinal block meant that he would do everything reasonably to be expected to see that she was not given one. He put the instructions on the chart, intending that the anesthetist should read and observe them. The anesthetist used a method the patient had told him not to use; he had read the record and did know of the patient's demand that no spinal block be administered. The jury's finding of fact were that the patient had not consented to spinal anesthesia and that the injuries were the proximate result of the assault. The anesthetist was held liable for assault.[23]

No Authorization Required in Emergency Cases

In an emergency, there can be no restriction on the surgeon's choice of an anesthetic; his judgment must prevail completely as to the selection of the drug. His duty is to use his best discretion and to devote his best efforts to the patient's needs. It is expected, however, that he will follow approved practices in every aspect of the operation.

In one case, a child aged seven, sustained a fracture of the forearm. The child was taken by the principal of the school to the doctor's office after the principal made an attempt to locate the mother and failed. The principal was accompanied to the doctor's office by another teacher, who remained in the office during the operation. Chloroform was administered to the child, who died a few minutes later. The mother claimed that the doctor was guilty of malpractice in failing to make proper examination of the child before placing her under the anesthesia, or in giving or causing to be given an overdose of chloroform, and in failing to obtain the consent of the mother before undertaking treatment.

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23. Woodson v. Huey, 261 P. 2d 199 (Okla.)

The evidence showed that an emergency existed; under such emergency, said the court, the physician was fully justified to proceed without the express consent of the child's mother. The doctor had followed the usual and customary practice among physicians in the same locality. The court dismissed the complaint.[24]

4. PREPARATION OF PATIENT FOR ANESTHESIA

The responsibility of the nurse anesthetist begins before she administers the anesthetic. Although it is not her duty to make a preanesthetic examination, she does have the obligation to ascertain that one was made by a medical practitioner. An examination of the patient's chart will indicate whether the necessary routine examinations or tests were made.

The preanesthetic examination will help to determine not only whether the patient should be subjected to anesthesia, but also the suitability of the agent or method in minor as well as in major surgery. She should know the nature of the anesthetic agent, its effects, and proper agent to use in face of possible cardiovascular, renal, respiratory, or other pertinent conditions.

Standards for Preanesthetic Examinations and Tests

While it is clearly the duty of the surgeon to make a preanesthetic examination in every case, the law does not specify when it is to be made nor how extensive it shall be, except that the practice must conform to a reasonable standard among physicians, in the light of the circumstances and the observations by the surgeon of his patient. Whether or not a second examination should have been made immediately preceding the administration of the anesthetic is also a matter of expert opinion. That death occurs while the patient is under anesthesia is not of itself proof of negligence.

Suit was brought for damages for the death of a patient, alleged to have been caused by a physician failing to make a physical examination immediately prior to the administration of the anesthetic. The surgeon examined the patient at his office and found that her heart and lungs were normal. She returned to his office the following morning for the operation; an examination of the bowel by means of a speculum was done while the patient was under anesthesia, occupying no more than three to five minutes. The patient died while under the anesthetic.

Testifying at the trial, the doctor maintained, although this fact was disputed by the patient's daughter who was present at the operation, that he made another physical examination before administering the anesthetic. One of the medical witnesses testified that no second examination was necessary, according to the standards of reasonably careful and skillful physicians. Since there was no evidence of any negligent act, the case was dismissed.[25]

The patient's attorney must establish not only the failure to make the required examinations, but also that the lack of such tests or examinations contributed to the patient's death.

Presence of Respiratory Infection

The record of the preanesthetic study of the patient may be protection in the event of a malpractice

24. Wells v. McGehee, 39 So. 2d 196 (La.)

25. Spain v. Burch, 154 S.W. 172 (Mo.)

claim against the surgeon or anesthetist. It may be proof of whether or not necessary tests and examinations were made and also whether the alleged conditions actually did exist. Although it is not negligence in itself not to record the results of the examinations, proof of the facts is facilitated if entries are made in the patient's chart.

The widow sued three physicians, alleging that her husband died as a result of a surgical operation for the removal of his gall bladder at a time when he had a cold and complained of painful heavy breathing. At the time of his admission to the hospital, his physician, a general practitioner, examined his heart and lungs, made a urinalysis and noted nothing wrong except "gall bladder symptoms." On the night before the operation, the surgeon examined the patient, had the temperature taken, spoke with him as to his symptoms and complaints, examined his chest with a stethoscope and found no signs of a cold. The anesthesiologist, 20 minutes before the operation, examined his lungs, ascertained blood pressure, pulse and temperature and asked whether a urine specimen had been taken. He decided the patient was a good risk. When the wound had been partially sewed, it was noted that respiration had ceased.

It was shown at the trial that the cause of the death, as certified by the medical examiner, was: "syncope while under the influence of ether administered as a surgical anesthetic for cholecystectomy — accidental." Factors in the death were arteriosclerotic nephritis and an organized pleurisy. A medical expert testified that the pleurisy might theoretically have been detected by the use of many x-ray films, but not practically; that the kidney condition "was not doing him any harm." The man's whole condition caused the death when ether was added to it. No reference to a cold was made by the pathologist. In the face of medical testimony that there was no abnormal condition of the heart, lungs or kidneys, and no cold at the time of the operation, and no findings by the medical examiner of unusual conditions which would make it improper to operate, the court dismissed the complaint. These were matters which could not be left to the common knowledge and experience of the jury. There was no medical evidence of negligence.[26]

One case illustrates the advantage of recording the physician's findings as to conditions contraindicating an operative procedure or the absence of such condition.

The patient alleged that an acute bronchitis developed about two weeks after an operation wherein the physician had administered ether knowing she was suffering from a severe head cold. Her medical witness and the physician-defendant both testified that the result of such an act would be to extend the infection downward, which might result in bronchitis. They also testified that the bronchitis should develop in two or three days with accompanying fever. While her medical witnesses attributed her bronchitis to the administration of ether at the time she had a cold, no one could say the patient had a fever. In view of the conflicting medical testimony it was for the jury to decide whom to believe. A verdict for the defendant would be proper under the circumstances.[27]

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26. Vartanian, Admx. v. Berman, 311 Mass. 249.

27. Butler v. Layton, 266 Mass. 117, 164 N.E. 920.

Failure to Make Laboratory Tests

Good medical practice requires the making of necessary laboratory examinations before an anesthetic is administered. However, medical proof that neglect to make the necessary tests was responsible for the patient's death must be shown to render the physician liable. The nurse anesthetist should ascertain that such an examination was made.

A patient suffering from an exophthalmic goiter consulted a surgeon, who advised surgery. Anesthesia was administered by the nurse. The operation progressed until about half of the goiter had been removed; suddenly the patient died. When the surgeon sued the husband for his fees for professional services, the latter counterclaimed for damages for the wife's death, alleging that no blood test was made prior to the operation; that such a test is usual to determine the oxygen-carrying power of the blood, which if below a given point, renders an operation of this character extrahazardous. The court held that the surgeon cannot be liable if the patient dies during the operation, unless there is proof that death was the result of negligence. Showing that no blood test was made, without proof of the specific test or its purpose and that the omission was a contributing cause of death, leaves the matter to speculation. Such testimony is insufficient to prove lack of skill. Dismissal of the counterclaim followed; the physician was held entitled to payment.[28]

Not every case of malpractice involves only the failure to do a particular test. Negligence may be based on the alleged failure to do a number of things in connection with the patient's preliminary care, such as physical examinations, laboratory tests, the competent administration of the anesthetic, etc.

It was alleged by the administrator of the estate of the deceased patient that the surgeon engaged for a herniotomy was under a duty to make a careful examination of the patient prior to the administration of an anesthetic, to engage a competent and careful anesthetist, and to supervise the administration of the anesthetic. The patient was about six feet tall and weighed 275 pounds. Ether was administered by the "open method" with the Esmark inhaler, the anesthetist being a medical student in his last year of a four-year course. He had studied the subject of administering ether, observed its adminstration in at least 1,000 cases, and had actually given ether before in eight or ten cases. During the procedure two other interns and physicians were in and out of the room. Not more than three ounces of ether were administered in the time required to get the patient completely under its influence. No unusual condition was noticed until after the patient had been lifted to the operating table. He was then observed to be cyanotic; the surgeon started artificial respiration; the patient seemed better. Taken back to the ward, respiration became labored; the patient died. Autopsy showed fatty degeneration of the heart and involvement of the valves.

The court dismissed the complaint for lack of evidence of negligence. It was not negligence to employ an advanced medical student to administer the anesthetic, especially if it is customary to do so in the locality in which the operation takes place. The proof was that the surgeon had made

28. Harvey v. Richardson, 91 Wash. 245, 157 P. 674.

a preliminary examination at his office of the heart and lungs and had both blood test and urinalysis made. "If it were not done, it would be an act of gross negligence."[29]

5. LIABILITY FOR ANESTHESIA FATALITIES

The first recorded death under anesthesia occurred about 100 years ago. Since then it has been established that death occurs about once in every thousand anesthetics given. The cause of such deaths may be cardiac, respiratory, or cerebral; they may be due to pre-existing disease, to the effects of surgical procedure, to the anesthetic itself, or to any combination of these causes.

Chloroform Deaths

The use of chloroform as an anesthetic has been largely discontinued, because its toxic effects upon both the heart and liver may be serious. The occurrence of death while under chloroform anesthesia is not of itself evidence of negligence; the negligent act of the surgeon or the nurse anesthetist must be proved as the proximate cause of the accident, to hold either one or both liable.

Within three minutes after the administration of chloroform, given during an operation to reduce a fractured arm, the child stopped breathing; death followed two minutes later. The autopsy report gave the cause of death as chloroform poisoning. At the trial, the surgeon testified that when the chloroform used is well diluted with air and the patient dies, it is with respiratory failure first, and a few minutes later with cardiac failure. If the chloroform is administered quickly and in too large amounts, there is cardiac failure first. He concluded the child did not die of an overdose of chloroform but as the result of a toxic condition produced by the chloroform. The doctor was held not liable, since there was no proof that the anesthetic was used negligently or that it was negligence to administer this anesthetic.[30]

The proof that the fatality was due to chloroform poisoning must be shown by competent medical testimony of the proximate cause of death.[31] This principle was applied where the plaintiff's medical witness, in one case, stated that he could not give the cause of death; another stated that the condition of the lungs did not support the theory that the patient had died of chloroform. This was not a case merely of conflicting expert testimony, said the court, but one in which no one said the anesthetic caused the death; there was no conflicting evidence for the jury to consider as questions of fact; the case was dismissed for lack of proof.[32]

Death Due to Allergy

The defense may be that death was caused by an allergy which could not be determined prior to the administration of the anesthetic, by any known tests.

A 19-year-old young man asked the doctor to use a local anesthetic. As soon as the injection of procaine was given in the back of the throat, the patient collapsed and died. The physician alleged death was due to the presence of the thymus gland, which ordinarily disappears during childhood, but persists and enlarges in some adults, making them peculiarly susceptible to shock. He asserted that the patient would have died if

29. Levy v. Vaughan, 42 App. D.C. 146.

30. Wells v. McGehee, 39 So. 2d 196 (La.)

31 Boucher v. Larochelle, 74 N.H. 433, 68 A. 870.

32. Yaggle v. Allen, 24 App. Div. 594, 48 N.Y.S. 827.

ether had been administered, and that there was no way of predetermining the condition. Medical evidence indicated that there was nothing to support the theory of death from procaine, but rather that it was a thymic death. The action was dismissed.[33]

In another case, the parents of a nine-year-old girl brought an action to recover damages for her death, which occurred while she was under anesthesia during an eye operation. The child had been given the usual preoperative tests. Ether was administered by a nurse anesthetist in the hospital's employ. During the operation the surgeon and nurse noticed that the child had become cyanotic. He immediately stopped the operation; efforts were made to resuscitate her, but in vain. Autopsy revealed that death was caused by an allergy to ether. According to the medical evidence, there is no known test to ascertain such an allergy prior to the administration of ether. Death resulted from an allergy which was unforeseeable. Such being the evidence, the case was dismissed.[34]

Anesthesia to Alcoholic Patients

No presumption of negligence in administering an anesthetic to an alcoholic patient arises from the fact that it was dangerous to do so, since there is an element of danger in every instance where a patient is anesthetized. Whether it is desirable or possible to postpone an operation on an alcoholic patient must be a matter of medical judgment, based on the various factors in the case. The nurse anesthetist, under the circumstances, cannot be the judge of the medical aspects of the patient's condition.

A patient suffered from a comminuted fracture of both bones of the forearm. He was seen by a doctor, but since he was under the influence of liquor another appointment was made. The patient returned, more sober than heretofore, although still showing the effects of drinking. He was kept overnight at the hospital. The doctor believed that the patient was in good enough condition to withstand the operation, but death occurred from the effects of the anesthetic before the operation was commenced.

The surgeon was charged with negligence in causing the anesthetic to be administered at a time when the patient was in unfit condition. From the fact alone that the patient died, the court said, no negligence can be inferred. There was no expert testimony of want of skill or negligence in administering the anesthetic. Whether the operation could have been postponed to a later date was not shown and must be considered a matter of speculation. It may not be left for a jury to conjecture. In the absence of such testimony the case was dismissed.[35]

Medical proof of the cause of death may become an insurmountable problem. It is sometimes difficult to show the exact reason for the patient's death because there may exist several possible causes. The law requires the plaintiff to establish the "proximate cause," which means the natural and efficient, but not merely incidental, cause of death. Where one cause is shown to be as likely as another, there is a failure of proof.

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33. Bishop v. Shurley, 211 N.W. 75 (Mich.)

34. Yeager v. Dunnavan, 174 P. 2d 775 (Wash.)

35. Loudon v. Scott, 58 Mont. 645, 194 P. 488.

An action was brought against a surgeon for damages for administering an anesthetic to an alcoholic patient and thereby causing his death. A medical witness testified that giving an anesthetic and operating on the decedent while he was intoxicated might have been harmful by necessitating the use of an undue amount of anesthetic, which might produce pneumonia, delirium tremens or heart failure. It was undisputed, however, that the decedent had not died from any of these causes; he died as a result of an embolism not produced by his intoxication. Even though intoxication was a proximate cause of death, embolism as a cause was equally supported by the evidence. The complaint had to be dismissed.[36]

Extent of Proof Required

The plaintiff need not demonstrate proximate cause with absolute certainty. He is not bound to exclude all possible causes of death. He must show only that it is more probable than otherwise that the fact is as he claims it.

Evidence was offered tending to establish the child died as the result of the negligent administration of chloroform. The surgeon contended that an embolism may have occurred or that the child may have been suffering from some rare and obscure condition to which the administration of chloroform would have a fatal result. He had little if any evidence concerning either condition. No autopsy was performed. The court held that the case should be allowed to go to the jury for decision; where chloroform asphyxiation is shown as the probable cause of death and the physician's evidence in defense merely suggests the possibility of the existence of other causes of death, the case is one for the jury. On the other hand, if there are two equally probable causes of an injury for only one of which the physician is liable, the jury may not be permitted to determine by conjecture which causes the death.[37]

Expert testimony is ordinarily necessary to establish causation in fatality cases involving anesthesia. Where there is conflicting testimony among the experts, it is for the jury to decide.

Opinion evidence must be found on expert knowledge. Usually, what is the standard of care required of a physician or surgeon or nurse is a question concerning highly specialized knowledge with respect to which a layman can have no reliable information. As to this, both the court and jury must be dependent on expert testimony. Ordinarily, there can be no other guide. For that reason, in many instances, proximate cause can be established only through the medium of expert testimony. There are other cases, however, in which non-expert jurors of ordinary intelligence may draw their own inferences from the facts and the circumstances shown in evidence. When the standard of care, that is what is in accord with proper medical or nursing practice, is once established, departure therefrom may, in most cases, be shown by non-expert witnesses.

Although it was claimed that the patient died from the use of ether, some of the medical witnesses testified that it might or might not have so resulted and that the decedent's heart was in such condition that he might have died momentarily. While one of the plaintiff's medical witnesses

36. Barker v. Heaney, 82 S.W. 2d 417 (Tex.)

37. Boucher v. Larochelle, 74 N.H. 433, 68 A. 870.

stated that if he had known of the condition of the decedent's heart he would not have administered ether, the statement was not the equivalent of saying that because the ether was administered it caused the patient's death. It could not be left to the jury to determine the cause of death if medical men were unable to determine it.[38]

Exception to Expert Testimony Rule

The courts generally recognize that the science of medicine is an experimental science, and they have been extremely careful to protect surgeons and nurse anesthetists against verdicts resting on nonexpert testimony in those cases in which nonexpert testimony could constitute nothing more than mere conjecture or surmise and in which only an expert could give a competent opinion or draw a reliable inference.

The plaintiff sued for damages for the death of his daughter alleged to have been caused by the negligence of the defendant physician. Her death was proved to be due to anoxia, in all probability caused by anesthesia. The jury found in favor of the plaintiff. In commenting on the jury's verdict, the court stated that when a patient remains in a comatose state for more than one and one-half or two hours after ether is administered, there is cause for alarm. The physician should immediately begin to administer oxygen, examine the patient for shock, and take other precautions, keeping in constant touch with the patient.[39]

38. Levy v. Vaughan, 42 App. D.C. 146.

39. Jackson et al. v. Mountain Sanitarium & Asheville Agriculture School et al., 67 S.E. 2d 57 (N. C.)

6. DOCTRINE OF RES IPSA LOQUITUR

The doctrine of res ipsa loquitur (the thing speaks for itself) places the burden of explaining the cause of the injury or death on those who had the instrumentality causing injury under their exclusive control. This doctrine brings into operation an inference or presumption of negligence when the injury is occasioned by some unexplained cause. If the injury suffered was the result of some explained cause or some specific act of negligence on the part of the surgeon or nurse anesthetist, which act is definitely described, there is no place for inference and the doctrine of res ipsa loquitur does not apply.

The burden is placed on the hospital, the surgeon, and the nurse anesthetist to show a definite cause for the accident. If they cannot explain the accident, they are required to show that the accident must have been due to some unpreventable cause.

Application of Doctrine in Tonsillectomy Cases

The first recorded application of the doctrine of res ipsa loquitur in an anesthetic death was in 1950 in a tonsillectomy case, caused by the negligent administration of anesthesia by a nurse anesthetist.

The patient was a child who was admitted to the hospital for the operation. Preoperative examination indicated the child had no pathologic or systemic disorders. The surgeon in 40 years of practice had performed hundreds of tonsillectomies with not a single fatality. It was held proper to instruct the jury that as a matter of law the occurrence of the accident gave rise to an inference of negligence that could be overcome only by

affirmative evidence explaining the cause of death, or by showing that it could not have occurred from any lack of due care. Based on the failure to offer a satisfactory explanation of the accident, the hospital was held liable for the erratic and excessive administration of the anesthetic gas by the nurse anesthetist.[40]

A surgeon and an anesthetist were sued for damages allegedly sustained because four "baby teeth" of a minor child were dislodged during a tonsillectomy, when a Davis-Crowe mouth gag was used to keep the patient's mouth open. This device put pressure on the four front teeth. Before applying the gag, the surgeon made a cursory examination of the patient's teeth, which he found to be apparently sound. During the operation, however, the four upper teeth of the patient were displaced, although there was no evidence indicating the exact cause of the displacement. The court held that the evidence failed to show any negligence on the part of the physician or the anesthetist. Instead, it clearly established that the child's condition was due to natural causes and not to the displacement of the "baby teeth" during the operation.[41]

The rule of res ipsa loquitur does not apply where the medical evidence gives a satisfactory reason for the patient's death during the course of or after a tonsillectomy. There must be evidence of negligence; it may not be presumed, under the circumstances, from the fatality alone.

Suit was brought for damages for the death of a patient shortly after a tonsillectomy. It was alleged that the surgeon injected an excessive and destructive quantity of nupercain or some fatal poison. No medical evidence was presented by the plaintiff. The doctor testified to a complete preoperative examination and no abnormal findings and that it was his opinion she died of an embolism. It was shown that another patient had died the day before, where the same quantity of the same anesthetic was used for a similar operation. The fact that the other patient died was no evidence of negligence in the instant case. The action was dismissed.[42]

Rule in Anesthetic Explosions

When an anesthetic explosion occurs in the operating room, the patient generally is unconscious; he is in no position to prove the cause of the accident. Although the personnel in the operating room may not always be in a position to determine the reason for the explosion, they may be better able to account than the unconscious patient. Unless the law casts the burden of expanation on the participants in the operation, the patient may never be able to obtain compensation for his injuries.

In the operating room there are many ways in which a flammable mixture may be ignited. Some of these means are apparent while others are not always well understood. The more common and obvious hazards of ignition are open flames, smoking, the use of live cauteries or diathermies, faulty electrical wiring and sparking electrical equipment.

A patient entered a hospital to have a wart on her nose removed and her tonsils excised. She was completely anesthetized by a nurse anesthetist; the surgeon used an electrical needle to remove the wart. As he was

40. Cavero v. Franklin General Benevolent Society, 214 P. 2d 854 (Cal.)

41. McBrayer v. Zordel, 257 P. 2d 962 (Colo.)

42. Johnson v. Anndt, 186 Minn. 253, 243 N.W. 67.

cauterizing the wound there was an explosion, described as a "flash" and a "pop" about six inches above the face and apparently within the oral and nasal passages of the unconscious patient.

The surgeon and anesthetist both testified that the ether was not turned on at any time during the operation. The nurse in charge of surgery asserted that it was a proper and customary procedure, in order to avoid contamination, for the anesthetist to wash the breathing tube with soap and water immediately before its use; that she saw the anesthetist wash the tube. The tank of nitrous oxide was not produced, nor was any explanation given for the failure to do so. No attempt was made to show by chemical analysis whether the gas was pure or contaminated. The court ordered the various defendants to prove their lack of legal responsibility for the accident; a new trial was granted for that purpose.[43]

The doctrine of res ipsa loquitur was held available to a patient, so as to entitle him to a judgment, where the hospital failed to rebut the inference of negligence from an explosion and fire which resulted in injuries to him. The surgeon had made an incision in the patient's side when the explosion took place, resulting in internal and external injuries to the patient's mouth, nose, throat, and head. Immediate suturing of the incision was done and a tracheotomy performed to facilitate breathing. A judgment of $15,000 was rendered against the hospital, because it failed to show it had taken every ordinary precaution to guard against the occurrence and the effect of static electricity in the operating room.[43]

Spinal Injuries and Res Ipsa Loquitur

The patient in spinal anesthesia cases, in order to make the doctrine of res ipsa loquitur apply, has the burden of proving that the result does not occur in the ordinary course of events without negligence.

The wife of an Army sergeant sought damages under the Federal Tort Claims Act for paralysis of her lower extremities that followed a spinal anesthetic, which she alleged was negligently given to her while a patient in a navy hospital, for the purpose of easing the pains of childbirth. The nature of the paralysis indicated damage to the nerves in the region of the cauda equina, which could have been caused by the needle trauma, chemical sensitivity or the administration of a contaminated anesthetic. Here the court found that the evidence showed that the anesthetic was not contaminated and that the injury was not caused by needle trauma, but was due to the patient's unforseen sensitivity to the drug administered. Consequently, the defendant was entitled to judgment dismissing the complaint.[45]

In most cases in which the rule of res ipsa loquitur is applied the situation is one which common knowledge and experience teaches that the result was one which would not have occurred if due care had been exercised. The patient is not required to eliminate all possible causes or inferences other than negligence of the defendant: all that is needed is evidence

43. Diermann v. Providence Hospital, et al., 188 P. 2d 12 (Calif.)

44. Andrepont v. Ochsner, 5 CCH Neg. Cases 2d 1462-(La.)

45. Hall v. United States, 5CCH Neg. Cases 2d 1425 (USCA 5th Cir.)

from which reasonable men can say that, on the whole, it is more likely that there was negligence associated with the cause than that there was not. The requirement that the instrumentality must have been under the management and control of the defendant does not mean, nor is it limited to, actual physical control; it is enough that the defendant had the right of control and opportunity to exercise it. Although the patient must show that the accident was not due to any voluntary action or contribution on his part, it is not necessary that he was completely inactive, but merely that there be evidence removing the inference of his own responsibility.[46]

Plaintiff entered a hospital as a routine obstetrical case. A spinal anesthetic was administered shortly before the birth of her baby, and the following morning plaintiff was allegedly paralyzed from her waist down. Her condition subsequently improved, but she was still partially paralyzed in her left leg and hip at the time of trial. She sued the obstetrician, the anesthetist, and the hospital, alleging negligence in the administration of the spinal anesthetic. At the conclusion of plaintiff's case the court granted defendants' motions for nonsuit. On appeal, the court held that the doctrine of res ipsa loquitur applied and that the question of liability should have been submitted to the jury.[47]

It does not necessarily follow in all cases of spinal injury that it is the duty of the persons who participated in the operation to explain the cause of such an accident. The patient may have been conscious and able to testify to the facts. In addition thereto the patient must produce expert testimony to prove negligence.

While the patient was conscious a spinal anesthetic was administered to him. He stated that at such time pain shot into his head and he felt as though he had been hit by something. He became nauseated, and later his right foot and right leg were paralyzed and numb and he was unable to urinate and had to be catheterized. The testimony established by medical proof and the patient's statements that the anesthetist had given the injection of the spinal anesthetic too high. It was a reasonable inference said the court, that the anesthetist was negligent.[48]

When what was done lies outside the realm of the layman's experience, medical evidence is required to show not only what occurred but how and why it occurred.

An action was instituted against a surgeon and an anesthetist for malpractice arising out of an emergency operation for an obstruction to the common bile duct. Spinal anesthesia was selected by the physicians; the anesthetic was administered through a needle inserted between the second and third lumbar vertebrae. During the operation gas-oxygen-ether was used to supplement the spinal anesthetic.

An expert testified that the pain was caused by the needle striking the nerve roots; that the recognized procedure is for the anesthetist to try to determine what caused the unconsciousness; further action would depend on what he learns. Another

46. Owens v. White Memorial Hospital, 292 P. 2d 288 (Cal. App.)

47. Seneris v. Haas, 291 P. 2d 915 (Cal.)

48. Huber v. Protestant Deaconess Hospital Assn., et al., 133 N.E. 2d 864 (Ind.)

expert stated the injury was a cauda equinal neuritis produced by the spinal anesthesia and that the nerve roots were injured down to the fifth sacral root. He further asserted that the anesthetic agent had a toxic effect on these nerve roots and caused the resultant paralysis, atrophy, and sensory changes. The unfavorable reaction of the patient, said another expert, could not be predetermined and was one of the hazards of anesthesia, producing "arachnoiditis." In dismissing the complaint, the court stated that the cause of the injury to the nerve roots and its effect upon the leg and adjacent organs must be explained by experts. The evidence ascribed the cause to the toxic quality of the anesthetic and not to the negligence of the anesthetist.[49]

There are state courts which reject the doctrine of res ipsa loquitur and require the patient to establish the cause of the injury and to prove negligence by expert medical evidence. The patient may be entitled in such cases to an examination before trial of the defendants to ascertain the facts of the accident.

Medical witnesses, in one case, agreed that it was dangerous to give a spinal anesthetic above the first lumbar vertebra, because of the presence there of the spinal cord. The proof showed that immediately after the spinal injection by two physicians the patient began to suffer intense pain; within a short time he was in a semi-comatose state and his body and organs were paralyzed from a point level with the area of injection downward. A test made about a week later disclosed the presence of blood in the spinal fluid. The evidence, held the court, supported finding that the negligent injection of the spinal needle into the patient's spinal cord or canal set in motion a natural and unbroken chain of events, rupture of a blood vessel, hemorrhage, destruction of the spinal cord, which led directly to the patient's paralysis, a reasonably foreseeable event.[50]

49. Ayers v. Parry, et al., 192 F. 2d 181 (U.S.D.C., N. J.)

50. Puryear v. Porter, 262 S.W. 2d 933 (Tex.)

The article published in this issue on the "Legal Aspects of Anesthesia Administration" will appear as a separate chapter in a new volume on law for nurses to be published later this year. The book has been written by our counsel Emanuel Hayt and his wife Lillian R. Hayt in collaboration with Miss Dorothy McMullen, R.N., Director of the School of Nursing, Sage College, Troy, New York, and August H. Groeschel, M.D., Associate Director, New York Hospital. It is planned to incorporate the present chapter in a separate book for nurse anesthetists.

A Ten Year Survey of Anesthesia in Spinal Cord Injuries

A. Estin Comarr, M.D. *
Mathilda Margison Woodard, R.N. *

The literature about spinal cord injuries has become abundant since World War II.[1] However, anesthesia and its relationship to spinal cord injuries does not appear frequently. The largest series reported to date is 167.[6]

The purpose of this paper is to ascertain (1) the number of operations that were performed with and without anesthesia, and (2) the types and techniques used for paraplegic patients. The operations were performed over a ten year period. Only those operations that were performed in the surgical pavilion were reviewed. It was not deemed feasible or practical to review the number of anesthetics used for the numerous cystoscopic procedures nor the various blocks for neurogenic bladder rehabilitation.

Results

3001 operations were reviewed for the type of anesthesia used. (Table I). 2014 (67%) operations did not require anesthesia. 987 (33%) required some type of anesthesia. The breakdown of those requiring anesthesia was as follows: sodium pentothal 598 (60%), sodium pentothal with endotracheal 222 (22%), spinal 47 (5%), local 106 (11%), cyclopropane 13 (1%) and caudal 3 (0.3%).

1072 genito-urinary operations were reviewed. 599 (56%) operations did not require anesthesia. 473 operations (44%) required anesthesia. The distribution among those requiring anesthesia was as follows: sodium pentothal 288 (61%), sodium pentothal with endotracheal gas anesthesia 72 (15%), spinal 31 (6%), local 80 (17%) and caudal 2 (0.4%).

183 neurosurgical operations were reviewed. 53 (29%) operations did not require anesthesia, 130 (71%) required anesthesia. The distribution among those requiring anesthesia was as follows: sodium pentothal 7 (5%), sodium pentothal with endotracheal gas anesthesia 113 (87%), spinal 9 (7%), local 1 (0.7%).

223 orthopedic operations were reviewed. 112 (50%) operations did not require anesthesia. The distribution among those requiring anesthesia was as follows: sodium pentothal 79 (71%), sodium pentothal with endotracheal gas anesthesia 7 (6%), spinal 5 (5%), local 13 (12%), cyclopropane 7 (6%).

1354 plastic surgery operations of decubitus ulcers were reviewed. 922 were closures and 432 were grafts.

*From the Paraplegia Service and Surgical Service (Anesthesia Section) of the V. A. Hospital, Long Beach, California, and from the Department of Surgery (Urology), School of Medicine, College of Medical Evangelists, Los Angeles, California.

TABLE I

Type of Anesthesia	None	Sod. Pent.	Sod. Pent. Endo.	Spinal	Local	Cyclo.	Caudal
Genito-Urinary Surgery							
Renal	4	66	68				
Cutan. Ureterostomies		11					
Transurethral Resections	92	80		17	10		2
Ureterolysis		3	3				
Perineal Urethrostomies	16	1					
Closure of Perineal Urethrostomies	16	5		1			
Ureterotomies & Plastics	2	20		2			
Hydrocoeles	2	1					
Bilateral Vesiculograms	50				2		
Vasotomies	7	7			4		
Circumcisions	153				22		
Testicular Biopsies	30	7			35		
Epididymectomies and epididymo-orchiectomies	29	7			2		
Bladder	1	3					
Ureterectomies		2	1				
Suprapubic Cystostomies	17	20		8	1		
Closure of Suprapubic Cystost.	34	27			2		
Cystolithotomies	2	6		2	1		
Closure of Penoscrotal Fistulae	128	20		1	1		
Excision Penoscrotal Diverticula	16	2					
Neurological Surgery							
Exploratory Laminectomies			67				
Chordotomies			16				
Rhizotomies	1		24				
Sacral Neurotomies	3			8			
Pudendal Neurotomies	47	6			1		
Nerves	2	1	6	1			
Orthopedic Surgery							
Resect. Head, Neck, Trochanters	4	8					
Disarticulation Hip & Amputations	6	4					
Achilles Tenotomies	10	3			1	1	
Modif. Ilio-psoas Operations	2	2	1	1			
Obturator Neurectomies and Adductor Myotomies	9	23		2			
Intrapelvic Obturator Neurectomies	1			2			
Other Major Procedures	40	36	6		10	6	
Toe Nail Procedures	40	3			2		
Plastic Surgery							
Ischial Decubitus Closures	342	105	6	2			
Sacral Decubitus Closures	168	40	7				
Trochanteric Closures	169	33					
Iliac Spines	11	3			1		
Intertrochanterics	15	3					
Malleoli and Heels	17						
Buried Grafts							
Sacral	187						
Trochanteric	95	1					
Ischial	48	1			1		
Multiple	42						
Other Sites	45						
Split Thickness Grafts	6	3					
Tube or Pedicle Grafts		1			2		
General Surgery							
Abdominal & Hernias	1	3	15		4	5	
Hemorrhoids	48	3			2		1
Other Rectal Operations	4				1	1	
I & D Abscesses	43	19					
Miscellaneous	9	9			1		

722 (78%) of the 922 closures did not require anesthesia. 200 (22%) required anesthesia. The distribution among those requiring anesthesia was as follows: sodium pentothal 184 (92%), sodium pentothal with endotracheal gas anesthesia 13 (6%), spinal 2 (1%), local 1 (0.5%).

423 (98%) of the 432 grafts did not require anesthesia. 9 (2%) required anesthesia. The distribution among those requiring anesthesia was as follows: sodium pentothal 6 (66-2/3%), local 3 (33 1/3%).

150 general surgical procedures were reviewed. 96 (64%) did not require anesthesia. 54 (36%) required anesthesia. The distribution among those requiring anesthesia was as follows: sodium pentothal 25 (46%), sodium pentothal with endotracheal gas anesthesia 15 (28%), local 7 (12%), cyclopropane 6 (11%), caudal 1 (2%).

19 miscellaneous procedures were reviewed. 9 (47%) did not require anesthesia. 10 (53%) required anesthesia. The distribution among those requiring anesthesia was as follows: sodium pentothal 9 (90%), local 1 (10%).

Discussion

Most surgery performed upon spinal cord injuries is elective rather than of an emergency nature. Therefore, there is always adequate time to prepare this type of patient for surgery. It goes without saying that the usual precautions are taken: chest roentgenogram, hemodetermination, and when the patient is over 40 years of age, an E.K.G. Sterile urines free from W.B.C. are the exception rather than the rule, and consequently are of little practical significance even though routinely performed.

The reader is invited to peruse the many articles dealing with nutrition of the paraplegic patient whose metabolism early after injury is abnormal in many instances regarding: protein levels and reversal of the A-G ratio, anemia, electrolytic problems, etc.[1]

We cannot agree with those who feel that "larger doses of depressant drugs are required for premedication".[6] Unfortunately, because of marked depressions during the early months following injury, physicians fall into the "sympathetic trap" to place these patients on continuous barbiturates and opiates for their various pains. Consequently, preoperatively the dosage is increased. At this center, the practice has been not to use opiates; barbiturates are used sparingly. A few moments spent by the ward physician or anesthetist the day before the operation will alleviate most of the apprehension, and save over 50% of the necessary pre-operative medication. The average patient, whose surgery does not require anesthesia, will at the most require Nembutal gr. 1-1/2 pre-operatively. Over the years we have found "verbal anesthesia" sufficient. For surgery with anesthesia we have found Demerol mg. 50 and Atropine gr. 1/150 to be adequate. To the extremely apprehensive patient Nembutal gr. 1-1/2 the night before will suffice.

Since these patients do not have voluntary rectal sphincter control, it is best that they have enemas the afternoon prior to surgery in order to prevent soilage on the operating table.

Patients who arrive in surgery with intraurethral, suprapubic or perineal catheters should have these tubes connected to a floor bottle for con-

tinuous straight drainage during surgery. We have not made a practice of inserting catheters into neurogenic bladders with a well-balanced function during surgery.

Positioning of the patient is of utmost importance on the table from two points of view: (1) adequate adjustment for respiratory exchange especially for patients in the prone or kidney positions; (2) adequate care to prevent formation of decubiti by means of pillows, sponge rubber pads and towels.

For all major surgery at least two units of whole blood are available during surgery and are used as indicated; intravenous fluids are used routinely. Emergency drugs are available as for any other patient, with one addition, namely, Bistrium (Hexamethonium Chloride); this is used for patients with lesions above the fourth to sixth thoracic segment.[1,4,7] We agree with Kurfee et al., that blood pressure, pulse and respiratory patterns of patients with other spinal cord injury levels do not reveal any unusual features.[6]

Post-operatively we have met with very little difficulty in most of our cases. Opiates are never ordered routinely. Levine tubes are inserted at the first sign of nausea or if the patient vomits once. Steam inhalations are started if the patient complains of hoarseness or discomfort caused by the endotracheal tube; lozenges have been effective at times.

Irrespective of whether the patient had an anesthetic or not, the catheter-free patient must be watched. If there is evidence of micturitional dysfunction, a catheter is introduced and the patient is placed on bladder training and/or tidal drainage.[1]

The tetraplegic patient must be watched very carefully for evidence of atelectasis and aspiration pneumonia. Tracheobronchial suction is necessary. Fowler's position and shock blocks under the foot end of the bed aid drainage. Manual compression of the abdomen by an attendant or nurse is very effective; also, abdominal binders aid coughing and expectoration.

The patient with a lesion at any cord level must be turned every 2-3 hours to prevent decubiti.

Deep breathing on the hour and carbogen on the half-hour are routine procedures.

Of the 987 (33%) patients who required anesthesia of some type there were no fatalities due to anesthesia. The most frequently used anesthetic was sodium pentothal (with or without endotracheal gas anesthesia) totaling 82%. This anesthetic agent was used because most of our operative procedures necessitate the use of electro fulguration.

We performed 105 ischial decubitus ulcer closures with sodium pentothal and 6 with endotracheal gas anesthesia, with the patient in the prone position. A severe laryngospasm occurred only once on a patient in the prone position without endotracheal gas anesthesia, but of such a magnitude as to assure us that the anesthetist is taking a needless risk. Therefore, regardless of the type of operation, if pentothal is to be administered in the prone position, it is our feeling that intubation is essential irrespective of duration of operation.

It should be noted that with all pentothal anesthesia nitrous oxide and oxygen are supplemented.

Muscular relaxants were unhesitatingly used prior to intubation in our patients.

Cyclopropane was used essentially by the general and orthopedic surgeons in our series.

Pathologic Autonomic Reflexes

As mentioned previously, the one emergency drug that should be available where spinal cord injuries are cared for is Bistrium (Hexamethonium chloride) for intravenous or intramuscular use. It is used for autonomic hyperreflexia in patients who have lesions above T4-T6; i.e., lesions above the sympathetic outflow to the abdominal viscera. Therefore most quadriplegic patients show this pathologic reflex. The average patient usually becomes stabilized and has fewer manifestations after 6 months to a year, with or without oral Hexamethonium therapy. But we have seen patients who have been stabilized for over 5 years, and who upon cystoscopy will show a blood pressure of 250-300/140 instantly upon introduction of the instrument. A variety of stimuli will set off this reflex, such as tactile and thermal stimulation of the skin and visceral distention or contraction. The viscus that is most responsible is the urinary bladder with the rectum next in order. The usual signs are sweating of the forehead, cutis anserina (goose-pimples), nasal obstruction and severe headache. At this time, examination reveals an elevated systolic and diastolic blood pressure with bradycardia.

The reflex mechanisms involved in these pathologic responses have been described (Fig. I) by Kurnick.[7] Since the bladder, upon distention, causes the pathologic reflex more often, this viscus will be used to describe the phenomenon. Stimuli arise from the mucosa and muscle, travel via the pelvic nerves to the spinal cord, and thence cephalad to the level of the cord lesion via the spino-thalamic tracts and posterior columns. On their way through the caudal cord stump these impulses cause a reflex outflow via neurons in the lateral horns; some create, by way of the sympathetic outflow pilomotor spasm, sweating and arteriolar spasm (with elevated blood pressure) and some cause, via the parasympathetic ganglia, pelvic visceral contraction. In the normal individual the increased blood pressure is picked up by receptors in the carotid sinus and aorta. This impulse is, in turn, relayed via the IXth and Xth cranial nerves to the vaso-motor center in the brain where efferent impulses are sent forth to the heart to cause bradycardia and also efferent stimuli are sent down the cord to the lateral horns, to inhibit the sympathetics for vasodilatation.

In lesions above T4-T6, the vaso motor center can respond to the stimuli from the receptors in the carotid sinus and aorta by bradycardia, but the vaso-motor center cannot send impulses past the site of lesion in the spinal cord to effect vasodilatation resulting in marked bradycardia and severe hypertension.

When the blood pressure is noted to ascend over 140 systolic or 100 diastolic, during the operation, 1/2 cc. (12.5 mg.) of Bistrium intravenously will usually stabilize the pressure. If necessary the dosage may be repeated. We have noted only one case of severe hypotension following Bistrium which was relieved by Trendelenburg position.

We insist that even then when it is not intended to use an anesthetic, a "standby" anesthetist is absolutely necessary for the recognition and treatment of: (1) the above described pathological autonomic reflexes, since

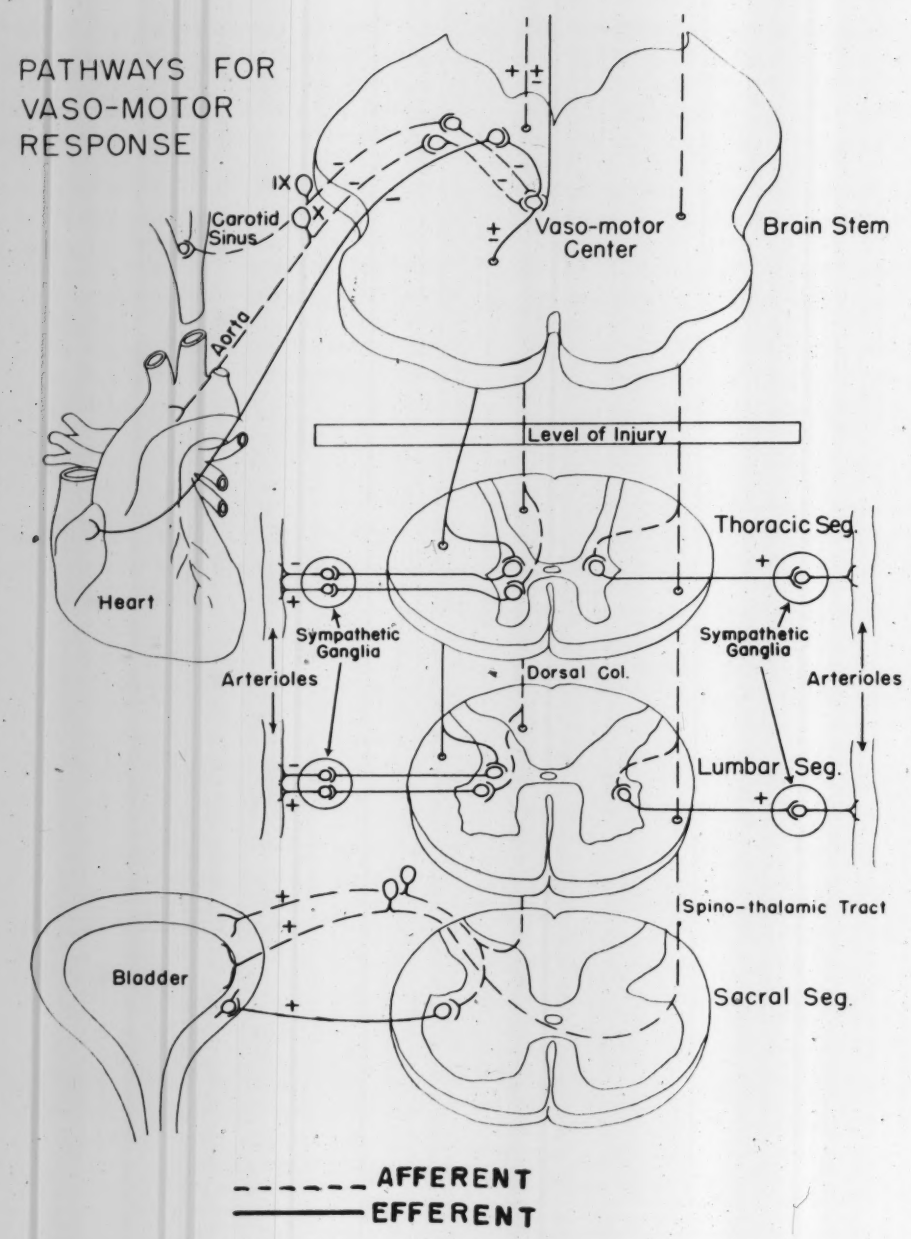

Figure I.
Pathways Affecting Blood Pressure Following Distention of the Urinary Bladder in Spinal Cord Lesions Above T4-T6 (Kurnick).

cerebrovascular accidents have been known to occur; (2) other blood pressure, pulse, and respiratory abnormalities incidental to blood loss, shock, cardiac pathology, and the like.

We have made it a routine to use Bistrium for all cystoscopic procedures not involving surgery in patients displaying pathological autonomic reflexes. To give Bistrium routinely before cystoscopy is unnecessary since there are those patients with lesions above T4-T6 who will not show a systolic level of more than 120 to 140 mm. of mercury (the usual normal pressure of a quadriplegic patient will range from 90-100/60-70). The anesthetist must closely observe the pressures immediately, during and following the introduction of the instrument, upon introduction of fluid into the bladder and every few minutes thereafter throughout the procedure.

If, from experience, the surgeon knows that he is dealing with a tetraplegic patient who has displayed these pathologic phenonema in the past, then either 1 cc. of Bistrium I.M. is given 20 minutes before cystoscopy, or 2-3 oz. of 1/4% pontocaine solution are instilled into the bladder for 20 minutes prior to cystoscopy; these precautions will usually suffice to prevent the phenomenon.

Choice of Anesthesia

If transurethral surgery is contemplated, such as transurethral resection of the vesical neck, resection of papillomata, litholopaxy, fulguration, and the like, spinal anesthesia is the method of choice. Recently it was observed that with a 100 cc. bladder volume, the blood pressure rose to 220/130 despite 1 cc. of Bistrium.

One of us (A.E.C.) has observed when visiting other hospitals where spinal cord injuries are cared for, that there is a reluctance to use spinal anesthesia. Our experience with cord injuries and spinal anesthesia would dispel this apprehension.

Spinal anesthesia is excellent also for operations upon patients with upper motor neuron lesions below T4-T6, who have general muscle or bladder spasticity, and who are scheduled to undergo extremity or bladder surgery.

Irrespective of the primary indication for spinal anesthesia, whether intended to prevent autonomic hyperreflexia or to provide relaxation of striated and smooth muscles, our drug of choice has been pontocaine.

The maximal amount used has been 8 mg. No untoward reactions have been noted to date. The effect was of sufficient duration for the operative procedures.

Anesthetic methods devised to balance the function of neurogenic bladders is a chapter in itself. Bors has written extensively about topical pontocaine anesthesia of the bladder, pudendal nerve blocks, differential sacral blocks, spinal anesthesia, and subarachnoid alcohol blocks and their respective effects.[2,3]

Conclusions

1. Sodium pentothal is our anesthetic of choice for spinal cord injuries.
2. Paraplegic patients in the prone position should have an endotracheal tube inserted even though the procedure is of short duration.
3. The importance of having Hexamethonium available as an emergency drug on the anesthetist's stand is emphasized.

4. A plea is made to recognize the effectiveness and safety of spinal anesthesia in spinal cord injuries.

5. Spinal cord patients tolerate surgery well; with no deaths or serious sequelae in 3001 cases.

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Report on Mass Casualty Course†

Clarene A. Carmichael, R.N., B.S. *

"In the event of attack with nuclear weapons, the nurse anesthetists will be worth their weight in gold" according to Dr. Robert Dripps speaking to a group at the Walter Reed Institute of Research. The institute is offering a series of courses on the Management of Mass Casualties and the amount of information crammed into five and one-half days is phenomenal. It is impossible to describe the impact of actually hearing the lectures and seeing the demonstrations, but possibly the most impressive single feature was the positive approach used. That is, in spite of the fact that multitudes would be injured in the event of nuclear warfare, there are ways and means of meeting the situation *if* everyone is properly trained.

Acceptance of the facts and preparation for any eventuality or utter chaos—which would you choose? Such a question needs no answer, but change the tense and ask "Which are you choosing?" Shockingly enough, there is a great possibility that, because of disinterest and inactivity, chaos wins by default.

The apathy with which many civilians meet the efforts of the Federal Civil Defense Administration is appalling. It behooves the nurse anesthetist to remember that possession of the special skills and attitudes inherent to the profession include a responsibility for public welfare. How much more efficiently such a responsibility can be discharged if time has been taken to become familiar with the types of problems expected and the principles of management of such problems.

This does not imply that nuclear warfare is inevitable, but the very first fact which must be accepted is that it is possible. War is as old as man. Lord Fisher said "The essence of war is violence. Moderation in war is imbecility." Nuclear weapons are available and have already been used in warfare. Regardless of the reasons or of the lives saved, the United States goes down in history as the first nation to use an atom bomb on an enemy.

When the fact that nuclear warfare is a possibility is accepted, the necessity for preparedness should also be granted. It is too late to find out what will protect against blast, thermal and radiation effects after the white flash, too late to teach the average man life saving first aid when his wife and children are bleeding to death before his eyes; and it is also too late for the medical profession and paramedical personnel to learn the principles of the management of mass casualties.

†Held in Washington, D. C., August 20-25, 1956.

*Educational Director, A.A.N.A.

Today nuclear weapons are of two types: fission and fusion. Fission occurs when a large atom such as uranium or plutonium is split into two parts by reacting with a neutron. The combined weight of the two new atoms is less than that of the original atom and the loss is accounted for by the release of energy. This is also known as an atomic explosion. Fusion occurs when two small atoms such as hydrogen are brought together to form helium. Here again the end product weighs less than the sum of the two original atoms and the loss has been converted to energy. An enormous amount of heat is necessary for this reaction and it is therefore known as a thermonuclear explosion. Fission bombs and fusion bombs are indeed capable of much greater destruction than any previously known weapons. The fact that the so-called small ones are measured in kilotons, which means the explosive force of 1,000 tons of TNT, and the large ones in megatons, or 1,000,000 tons of TNT, sounds quite overwhelming. The energy released is manifested as blast, heat and radiation.

Blast is measured in pounds per square inch overpressure and it is surprising to find that 2 p.s.i. destroys glass, wood and masonry; concrete structures will probably remain erect at 10 p.s.i.; 15 p.s.i. destroys everything but earthquake resistant structures; and the human body can take up to 100 p.s.i. It is not too comforting, however, to realize that withstanding the direct blast effects is relatively minor compared to indirect blast effects caused by collapsing structures and flying objects. Injuries from this cause will be fractures and lacerations.

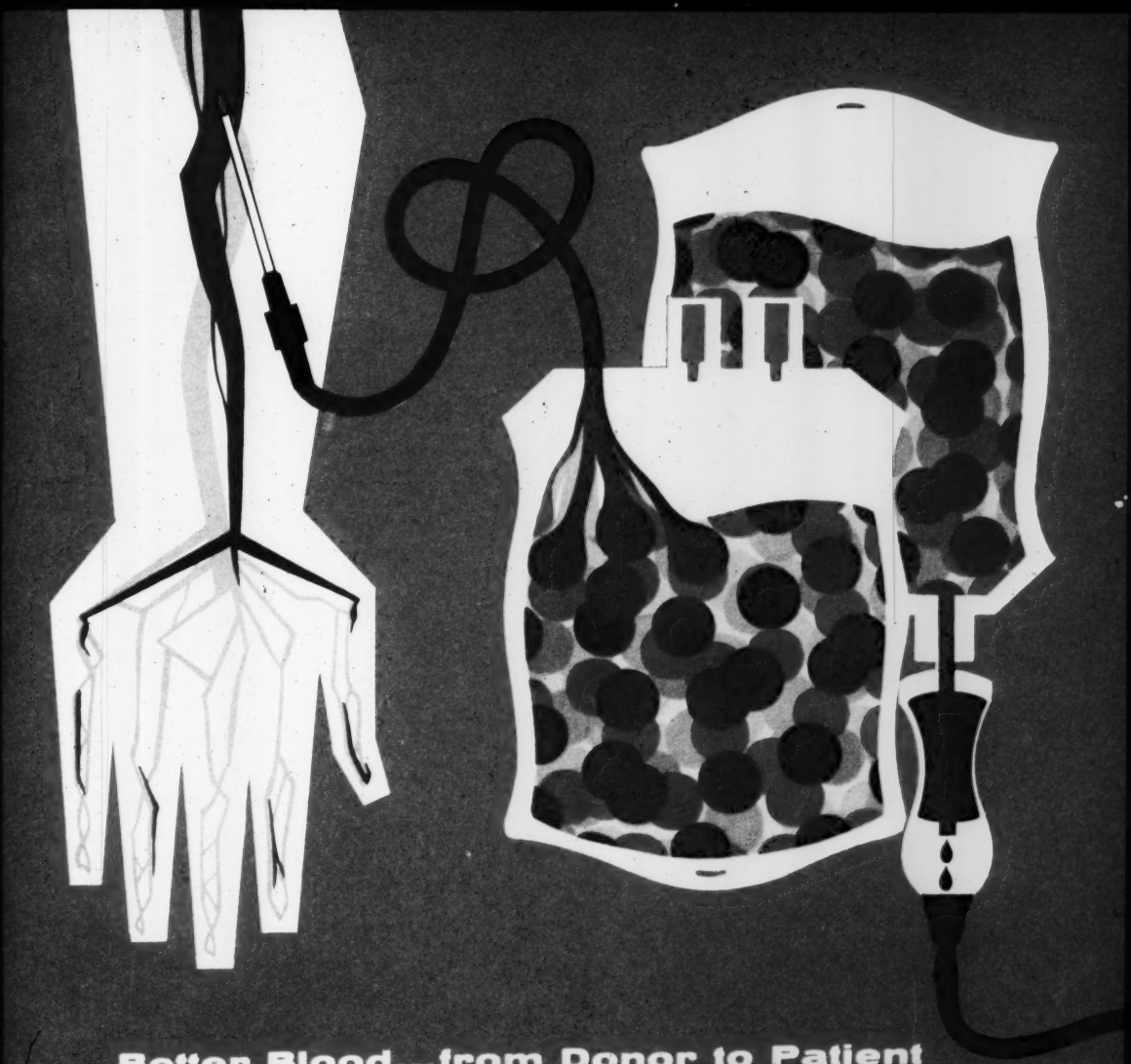
Heat, or thermal radiation burns occur so soon after detonation (within first one-half second) that evasive action is useless. Thermal radiation travels in a straight line and being shielded by a building is protection. Clothing does act as a shield—light clothing reflects and dark absorbs. Wool and cotton are most effective. Nylon and other synthetics tend to burst into flame and cause flame burns as well as allowing thermal radiation burns. Thickness of cloth and number of layers are positively related to protection.

Many secondary fires will result and "fire storm" may occur in which case a great number of flame burns would be added to the casualties from thermal radiation.

The new casualty-causing factor brought into play by use of nuclear weapons is radiation. The concensus of opinion seemed to be that this would not be an immediate problem in handling the casualties. If enough prompt radiation is received to produce immediate symptoms there is no chance of survival. If symptoms are delayed for a few days, it is hoped that hospital facilities will be well enough organized by that time to properly diagnose and treat radiation sickness.

The first few hours after detonation will be the time when those in the medical field will be most sorely taxed and must work at optimum efficiency to avoid useless waste of life. The most vital job will be that of sorting, which means assigning priority for treatment. The present concept seems to be that first sorting will be on the basis of four categories:

1. Minimal treatment — Those who may be returned to duty immediately. This would include a large number of people who might ordinarily require hospitalization.



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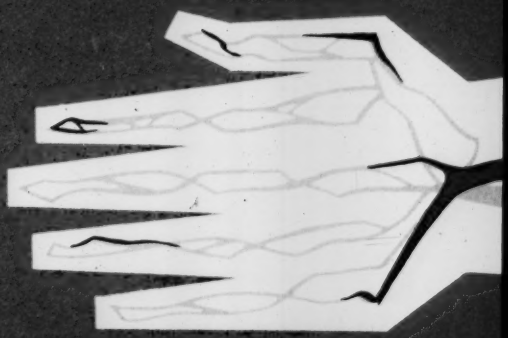

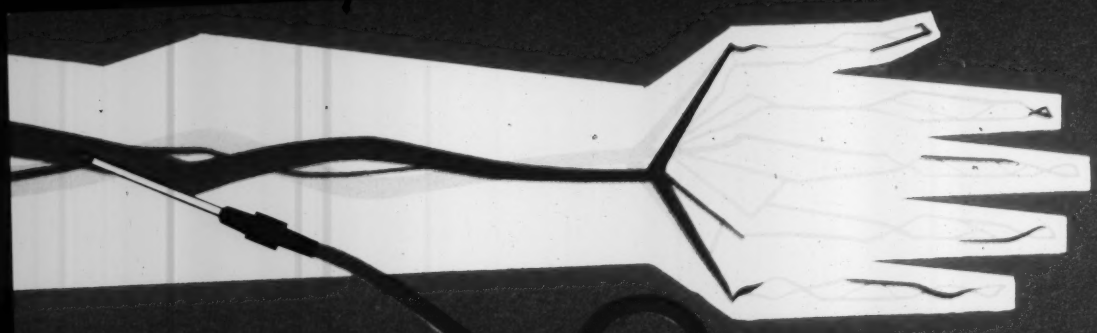

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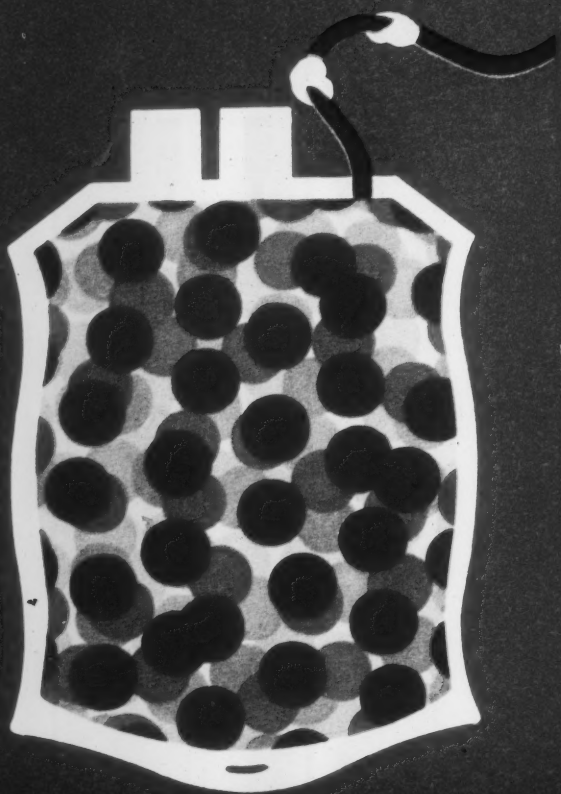

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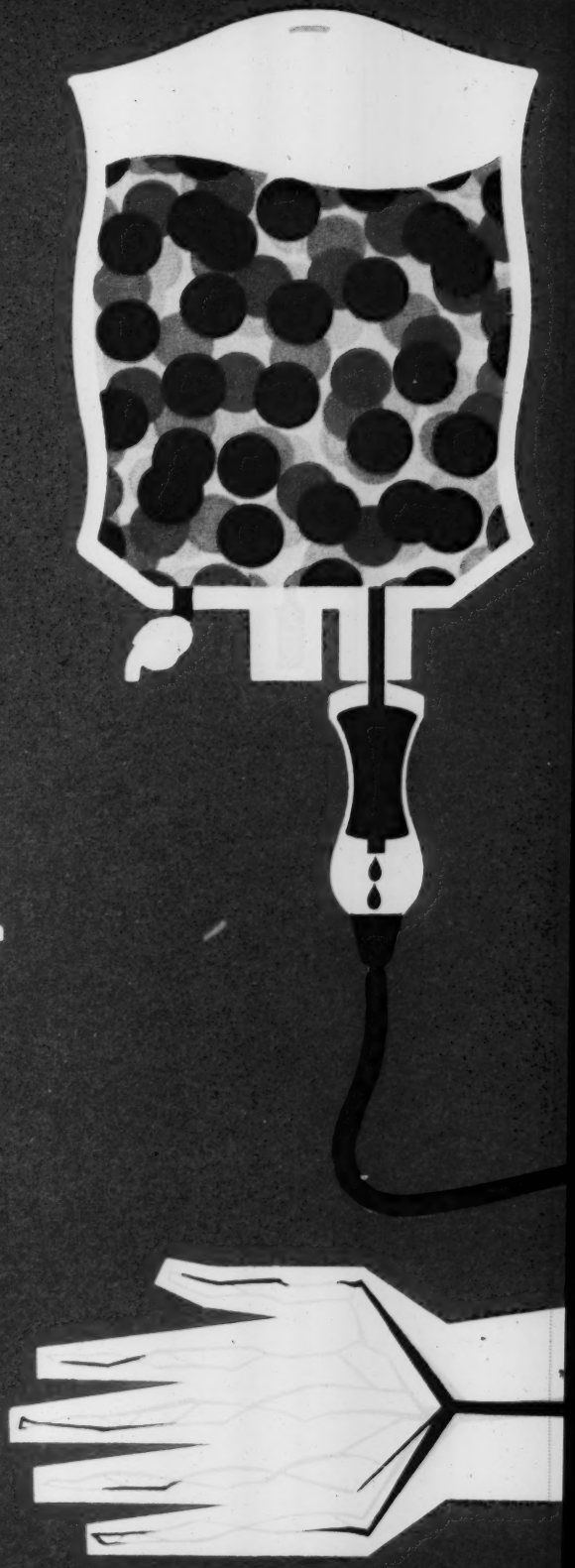

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4. Expectant Treatment — Those who are critically injured and can be saved only by long, complicated procedures.

The person responsible for this sorting will be the person having the most skill along these lines and would ideally be a chief surgeon. If a surgeon is not available, it falls to the next best qualified person to carry out these duties until relieved by someone with better qualifications

The question may arise "Specifically, what is the nurse anesthetist doing?" The nurse anesthetist is doing the same thing all other nurses are doing—utilizing special skills in the way in which they will prove most effective under the existing circumstances. After the immediate crisis is over and anesthesia is again possible, the nurse anesthetist will probably be supervising numerous untrained hands. If endotracheal equipment is available, the airway problem will be somewhat easier but it seems probable that many a day will pass before the ratio of one trained anesthetist per patient will again be achieved.

Muscle Relaxants

Mary Karp, M.D. *
Chicago

History

The modern use of muscle relaxants is less than 15 years old. In this short time these drugs have revolutionized anesthesia. Before the muscle relaxants, deep general anesthesia or spinal anesthesia were the only means available to provide good working conditions for difficult abdominal operations, and both of these methods carried with them considerable hazard to the patient.

The paralyzing effect of curare had been known since the 16th century. Reference was made to a potent arrow poison used by South American Indians, in the letters of Pietro Martire d'Anghera in 1516, and by Sir Walter Raleigh in 1595. Charles Waterton in 1825 described accurately the progression of the paralysis which followed the injection of curare, and showed that a curarized animal could be resuscitated if the lungs were artificially ventilated by means of a bellows.

In 1857 Claude Bernard elucidated the nature of the paralysis; and for nearly 100 years curare has been used in physiological experimentation. Curare was given a fairly extensive clinical trial in Europe and America late in the 19th Century, but it was considered too toxic, probably because of impurities of the crude drug which came from the Indians of the Amazonian Jungle. In 1938 Richard Gill brought to the United States from Guiana a large quantity of raw material from which Intocostrin was purified and standardized. The isolation and identification of the active principle (the pure crystalline chloride) of tubo curare by King[1] overcame one of the major obstacles to the successful use of the drug in clinical medicine. Burman and Bennett used it clinically in spastic children and in electroshock therapy. Lou Wright in 1940 suggested its use in anesthesia. Griffith and Cullen used it first in anesthesia.

The revelation of the structural formula of the alkaloid d-tubocurarine, revived interest in the synthesis of compounds that would reproduce the pharmacological effect of curare. Since that time a large number of compounds have been made and examined as to their muscle-relaxing ability. Among the synthetic drugs that have emerged from the laboratory into commercial use in clinical medicine are dimethyl ether of d-tubo curarine, decamethonium, gallamine triethiodide, benzoquinonium chloride, laudolissin and succinylchoride.

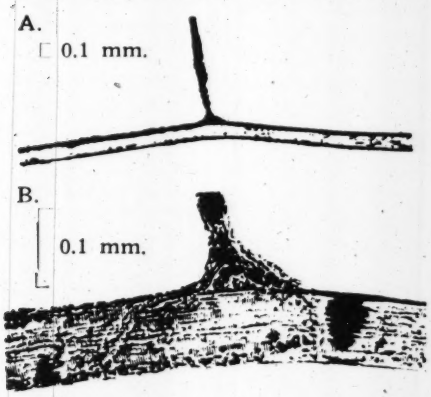
Presented at the Annual Meeting of the American Association of Nurse Anesthetists, Sept. 20, 1956.

*From the Department of Anesthesia, Division of Surgery, Northwestern University Medical School, and Department of Anesthesiology, Chicago Wesley Memorial School, Chicago, Illinois.

Normal Neuromuscular Transmission

To understand how muscle relaxants produce neuromuscular block, it is important to comprehend the mechanism of normal neuromuscular transmission. The present conception is based on the chemical theory that

Diagram of muscle fiber with end-plate. Nerve fiber ends on end-plate, which becomes depolarized (indicated by dots) by the released acetylcholine. (Feldberg, W.: Brit. M. J., 1:967, 1951.)



Photograph of a living single muscle fiber with its nerve supply.

A, low magnification

B, higher magnification. (Kuffler, S. W.: J. Neurophysiol., 5:18, 1942.)

Figure 1. Neuromuscular junction.

acetylcholine is the all-important link in the transmission of an impulse from motor nerve to muscle fiber.

The neuromuscular junction is made up of 3 parts: 1, the end of the nerve fiber, 2, the protein membrane between nerve and muscle fiber (called end-plate or receptor) with its post-junctional membrane, and 3, muscle fiber (Fig. 1). In the resting state, the inside of the structure remains at a lower potential than the exterior. When a motor nerve impulse arrives at the end of the nerve fiber acetylcholine is released from an inactive precursor. The acetylcholine molecule becomes attached to certain receptors in the end plate, and in so doing alters the membranes' permeability characteristics, rendering it freely permeable to ions and causing a change in the electrical potential normally present on either side of this membrane. This is termed depolarization. When this potential reaches a certain threshold, a trigger mechanism is produced which causes the same changes in the adjacent part of the muscle fiber, so that a wave of depolarization followed by contraction spreads along the whole muscle fiber.

The acetycholine is almost instantaneously hydrolyzed to acetic acid and choline by the enzyme cholinesterase present in the tissues; and these combine with the specific protein to reform the acetylcholine precursor, and the end plate region regains the resting potential, becoming repolarized (Fig. 2).

The cholinesterase system plays an important role in the depolarization—repolarization sequence of the post junctional membrane in normal neuromuscular transmission. There are two different types of enzymes capable of hydrolyzing acetylcholine: 1, the acetylcholine esterase or true cholinesterase, and 2, the plasma cholinesterase or pseudocholinesterase. The former is found in red blood cells, nerve cells and muscles. The latter is present in the plasma. The plasma cholinesterase activity is of major importance, for the duration of neuromuscular block will depend on the circulating plasma volume and

NEUROMYAL TRANSMISSION

Normal Sequence of Events

1. Nerve impulse
2. Release of acetylcholine
3. Depolarization of post-junctional membrane
4. End-plate potential ("trigger" mechanism)
5. Contraction of muscle fiber
6. Destruction of acetylcholine
7. Repolarization of post-junctional membrane

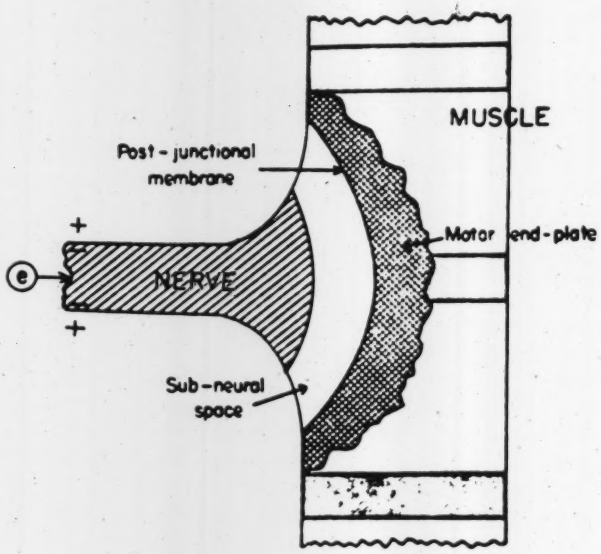


Figure 2. Normal neuromuscular transmission.

cholinesterase activity of the plasma. The plasma cholinesterase activity can be diminished in patients with low plasma protein levels associated with liver disease, malnutrition, severe anemias, cachexia, dehydration, intoxication with anti-cholinesterase insecticides and war gases.

Mechanism of Action

Claude Bernard between 1847 and 1857, performed classical experiments to show that the paralysis following the injection of curare was peripheral and not central in origin. He ligated one lower limb of a frog so that it was deprived of all its blood supply, leaving the sciatic nerve intact. The injection of a solution of curare into the dorsal lymph sac resulted in paralysis of all the skeletal muscles except those of the ligated limb, which still responded to stimulation of the sciatic nerve. The paralyzed muscles reacted still to direct stimulation. Stimulation of the skin in the paralyzed part of the animal resulted in reflex movement of the ligated limb (Fig. 3). Therefore, he proved that the paralysis was brought about by some interference peripherally and not by any depression of the central nervous system. He then placed the nerve of one frog's gastrocnemius nerve muscle preparation and the muscle of another gastrocnemius nerve muscle preparation in the curare solution. Stimulation of the curarized nerve resulted in contraction, but no contraction resulted in the second, when the nerve was stimulated, although the muscle itself reacted to direct stimulation. Bernard concluded that curare acted not on the nerve or the muscle substance, but on some junctional tissue between the one and the other (Fig. 4).

Neuromuscular block may be due to competitive inhibition, depolarization, or may be a dual type.

I. Competitive Inhibition (or Non-depolarizing Block-Curarelike): d-Tubocurarine, dimethyl ether of d-Tubocurarine, mytolon, flaxedil, and laudolissin act in this manner. Drugs of this group produce neuromuscular block by interference with normal depolarizing action of acetylcholine. They raise the threshold of the post junctional membrane to acetycholine. This type of block is antagonized by anticholinesterase drugs such as physostigmine or neostigmine and by tensilon. There is potentiation of block potency under ether anesthesia (Fig. 5).

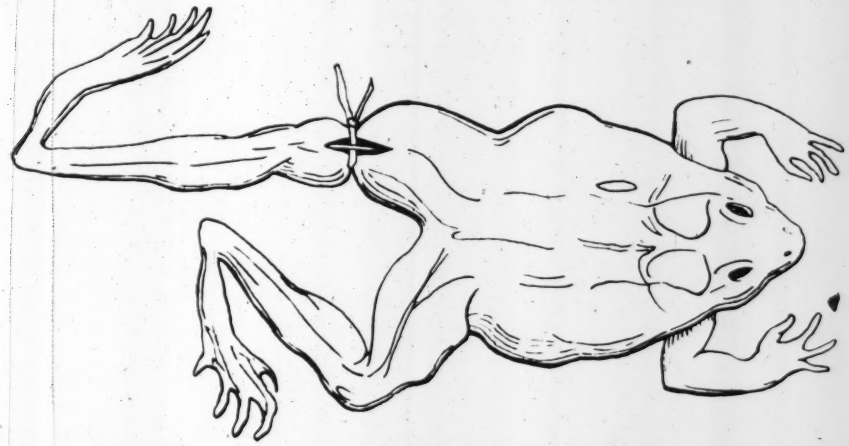


Figure 3. Claude Bernard's Curare experiment: frog with ligated limb. Sciatic nerve outside ligature.

II. Depolarization block (C-10-like): This is similar to the block produced by acetylcholine in normal transmission, but there is increased duration and extent of depolarization. Succinylcholine block lasts only a few minutes because it is rapidly hydrolyzed by the plasma cholinesterase into succinylmonocholine, which in turn is broken down to succinic acid and choline. In contrast the action of C10 (Decamethonium) is prolonged because it is not hydrolyzed but is excreted unchanged in the urine.

The block is preceded by muscle twitches which represent the contraction of the muscle fibers before the onset of persistent depolarization and neuromuscular block. The contraction of muscle fibers cannot occur again until the post junctional membrane becomes repolarized and therefore the muscle fibers remain in a state of paralysis during the period of depolarization. There is no reversal of this type of block by anticholinesterase agents in man, but antagonism exists in monkeys, mice and dogs. There is no effect of diminution of potency under ether anesthesia (Fig. 5).

III. Dual block: occurs in myasthenia gravis and possibly in certain circumstances after intravenous injection of the depolarizing drugs, C10 or succinylcholine, in normal subjects.

If d-Tubocurarine is given to a patient with myasthenia gravis, those muscles which are clinically weak have hypersensitivity. If C10 is given, the response varies with the degree of muscular weakness already present. If there are minimal symptoms, large doses of C10 (10 mgms. and more)

produce no paralysis. If there are severe symptoms, with generalized weakness, 1½ or 2½ mgms. of C10 may show paralysis and this may be reversed by neostigmine or tensilon. Thus, there is a dual response to C10 in myasthenia gravis, one a depolarizing response, the other a competitive inhibition response. Occasionally, a similar dual response will be seen following the administration of succinylcholine or C10 in apparently normal individuals, and neostigmine or tensilon may antagonize the block.

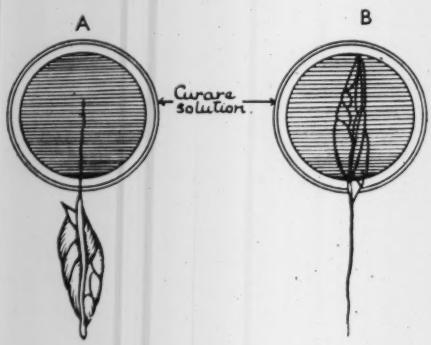


Figure 4. (A) Gastrocnemius nerve preparation, with nerve in curare solution. (B) Gastrocnemius nerve preparation, with muscle in curare solution.

Muscle Relaxants in Clinical Use

I. d-Tubocurarine chloride: It is a quarternary alkaloid, one of the most important isolated from curare. Chemically it is a bis-benzyl-iso-quinoline derivative (Fig. 6).

It is available as Intocostrin (20 units per cc.) and d-Tubocurarine chloride (3 mgms. per cc.). 30-40% is excreted in the urine within 3 hours. The fate of the remaining fraction is not known.

There is considerable diversity of opinion concerning its action on the central nervous system. Some investigators are convinced that it interferes with perception of stimuli. Others feel that its sole effect is muscular. In large doses, it has a depressant action on autonomic ganglia, but this is not important in clinical practice. The occasional transient fall in blood pressure might be due to a combination of this effect with the liberation of histamine.

When injected intradermally it produces a typical histamine wheal; and bronchospasm has been reported following its administration during anesthesia. However, most anesthesiologists do not consider it contraindicated for asthmatic patients.

It does not affect the electrocardiogram nor the myocardium even in large doses.

It has no direct oxytoxic effect on the uterus. In clinical doses it does not pass through the placental barrier and no after effect has been re-

EFFECT OF NEUROMUSCULAR BLOCKING AGENT

A. Curare-like (Competitive inhibition)

1. d-Tubocurarine
2. Dimethyl ether of d-Tubocurarine
3. Mytolon
4. Flaxedil

Inhibit normal depolarizing action of acetylcholine

a. Steps 1 and 2 unchanged (Fig. 2)
b. Steps 3 and 4 blocked (Fig. 2)
c. Paralysis ensues

B. C-10-like (Depolarization)

1. Decamethonium
2. Succinylcholine

Produces persistent depolarization of post-junctional membrane

a. Steps 1 and 2 unchanged (Fig. 2)
b. Next contraction does not occur until post-junctional membrane is repolarized

Figure 5. Neuromuscular blocking mechanisms.

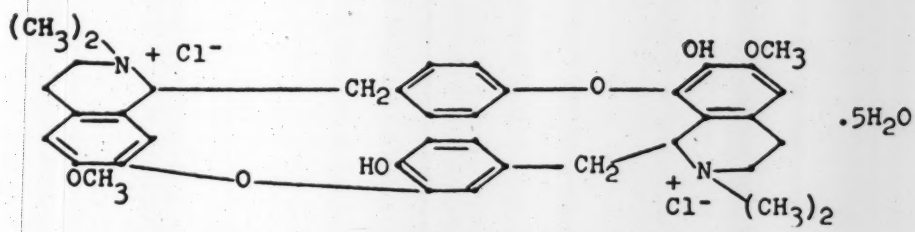


Figure 6. d-Tubocurarine Chloride

ported in the baby following its use with anesthesia for cesarean section.

Patients with myasthenia gravis are hypersensitive to d-Tubocurarine. Genuine cases of marked sensitivity which show no signs of myasthenia gravis have been reported.

One of the most striking properties of d-Tubocurarine is the remarkably uniform response of the various species of animal to the substance.

II. **Dimethyl Ether** of Tubo-Curarine: (Fig. 7) It is 4 to 5 times more potent than d-Tubocurarine. It depresses respirations less than d-Tubocurarine in equally potent doses. According to Collier and Hall and others, it is less active than the original alkaloid in histamine production and depression of autonomic ganglia.[2]

It is believed to have a shorter duration of action than d-Tubocurarine, though this has not been my clinical experience. I consider it to have an action at least 50% longer than d-Tubocurarine. Because of its potency, reduced depression of respiration and duration, it has taken the place of d-Tubocurarine in my practice.

Synthetic Agents

As long ago as 1869, it was suggested by Crum, Brown and Fraser that the important characteristic of the acetylcholine molecule was the quaternary nitrogen atom, and that quaternary nitrogen compounds might be used as substitutes for curare. The optimum distance for quaternary nitrogens to be separated corresponds to a space occupied by 10 carbon atoms on a methylene chain, i.e. 12-14 Angstrom units (1 A = 0.001 micron). These considerations apply both to agents which closely simulate acetylcholine and to agents acting by competitive inhibition such as d-Tubocurarine and gallamine.

III. **Gallamine Triethiodide** (Flaxedil): (Fig. 8)

Its action on the myoneural junction is the same as d-Tubocurarine. Neostigmine is an effective antidote.

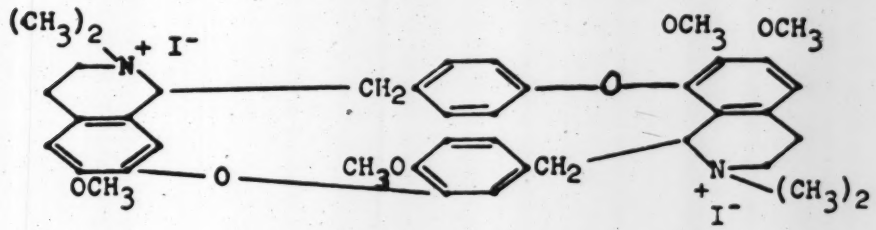


Figure 7. Dimethyl Ether of d-Tubocurarine Iodide (Metubine® Iodide Mecostrine® Chloride).

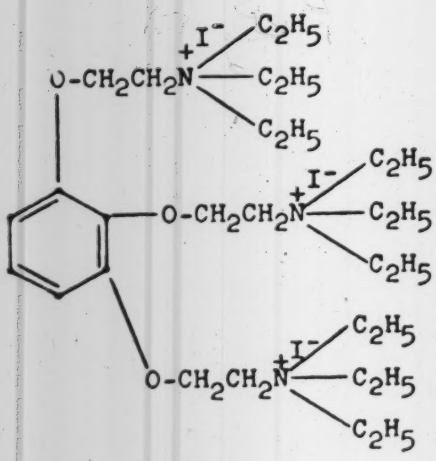


Figure 8. Gallamine Triethiodide (Flaxedil®).

Its potency is 1/3 to 1/5 that of d-Tubocurarine. The autonomic blocking effects on the sympathetic ganglia are negligible. However, it does produce a blockade of the cardiac vagus that is similar to atropine in potency and duration. A tachycardia of 20-60% invariably accompanies its use. Also it may cause bronchial dilation. It liberates 1/2 to 1/5th as much histamine as d-Tubocurarine. It has no vasodepressor effects.

Because of its vagolytic effects, it is especially useful in asthmatic patients. It lasts about 20 minutes. It is effective for peritoneal closure if the effects of d-Tubocurarine or Laudolissin have worn off.

IV. Laudolissin: (Fig. 9)

Originally developed by Collier and Taylor in 1949—51, it has a chemical formula similar to that of d-Tubocurarine in that it is a bis-benzyl derivative, but differing in that it is heterocyclic and has a decamethylene side chain.

It acts by competitive block at the myoneural junction.

It is similar to d-Tubocurarine and is reversed by the same antidotes. It is ½ as potent as d-Tubocurarine, and in clinical practice 2 mg. of Laudolissin are equivalent to 1 mg. of d-Tubocurarine. Its duration is somewhat longer than d-Tubocurarine (40-50 minutes) and its action is slower in onset (5 minutes as compared to 2 minutes). There is no change in blood pressure or pulse rate. Its histamine release is about the same as d-Tubocurarine. It exerts no marked effect on the autonomic ganglion or the vagus. It holds promise of being useful as a synthetic substitute for d-Tubocurarine in long operations.

V. Benzoquinonium (Mytolon Chloride): (Fig. 10)

It is an ammonium alkly-aminobenzoquinine.

It was studied in 1949 by Soria and Hoppe. Although effective as a relaxant, it has parasympathomimetic

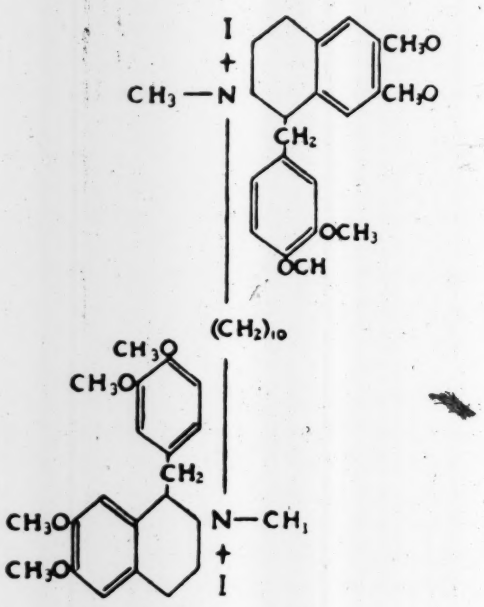


Figure 9. Landolissin

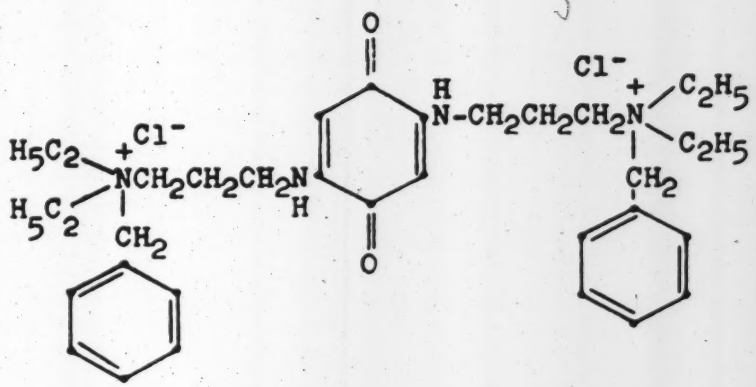


Figure 10. Benzoquinonium Chloride (Mytolon® chloride).

side effects which reduce its clinical usefulness. In conscious volunteers a severe colic and intense salivation occur in clinical doses. Also during anesthesia, bradycardia and salivation are common and troublesome. It has anticholinergic activities — 1/4 that of neostigmine. Therefore, it is not likely to replace other synthetic relaxant agents.

Neostigmine is less effective as an antidote than is usual with competitive blocking agents.

It has properties similar to d-Tubocurarine but also effects similar to decamethonium. It is especially interesting from a pharmacologic standpoint because of this dual mechanism of action.

VI. Decamethonium Iodide (Syncurine) C10: (Fig. 11)

It was studied by Paton and Zaimis in 1948. Maximum paralysis lasts about 20 minutes. It possesses no significant ganglionic blocking activity, anti-muscarinic activity, histamine-liberating properties or apparent anticholinesterase activity at therapeutic levels.

There is no real antagonist. Neostigmine and Tensilon exacerbate the the paralysis. C10 is excreted almost in its entirety in the urine.

VII. Succinylcholine Chloride: (Fig. 12)

It is a unique compound. Literally it represents an end-to-end union of two molecules of acetycholine. As

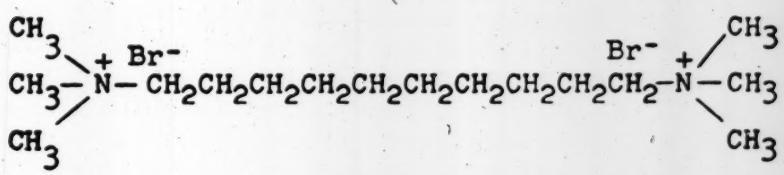


Figure 11. Decamethonium (Syncurine®, C-10).

such it resembles decamethonium both in structural design and in nature of the quaternary nitrogen centers.

Succinylcholine resembles C10 in its general pattern of action with the exception that its duration of action is distinctly shorter owing to rapid hydrolysis by pseudocholinesterase.

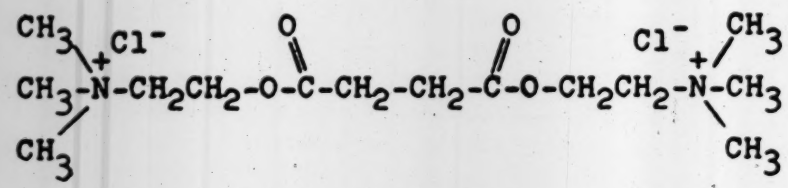


Figure 12. Succinylcholine Chloride (Anectine® chloride, quillicin).

Therefore, it can be regulated with considerable precision by means of continuous infusion. Due to individual variations in different patients the dose of any muscle relaxant is administered on a purely empirical basis. Because of this, errors in judgment cannot be avoided. Errors in long-acting muscle relaxants will not be manifest for several minutes, if too small and will persist if the dose is too high. With succinylcholine, an inadequate dose will be seen within 60-90 seconds, and if the dose is excessive effects of overdose will wear off within a reasonably short time even in patients with decreased plasma cholinesterase activity.

When succinylcholine and ester type local anesthetic agents are used together, since both are hydrolyzed by plasma cholinesterase, a substrate competition between the two compounds for the enzyme will develop. Therefore, pharmacologic effect of both compounds will be augmented, and comparable degrees of muscle relaxation can be maintained by administering smaller mg/min. doses of succinylcholine.[3]

The dose which will paralyze skeletal muscles without producing respiratory depression is ½ that required to produce respiratory arrest.

The paralysis following a normal dose of 50 mgms. lasts 4 to 6 minutes.

It has no ganglion blocking effects. Increased salivation does not ordinarily occur in humans. It has very little or no histamine release. There is no significant E.K.G. effect. The blood pressure is unaffected or will rise slightly and there are no known effects on parenchymatous organs.

It has replaced all other relaxant agents for intubation and endoscopic work. It also can be used effectively for closure of the abdomen at the end of long operative procedures in which other relaxant agents have been employed.

The jerky movements of the diaphragm, so commonly seen with other paralyzing drugs, are not seen with succinylcholine. Whatever the reason, the resultant respiratory activity is much less disturbing to the operative field. Neuromuscular block takes place smoothly.

Foldes reported some mild vagolytic effects characterized by increase in pulse rate. However, there were no effects upon sympathetic ganglia with

consequent falls in blood pressure as occasionally is seen with d-Tubocurarine and no evidence of histamine release.

Anti-Curare Agents

Man had knowledge of the classical paralyzing property of curare for some hundreds of years before he found a means of dissipating this action. In 1900 Pal demonstrated that the alkaloid, physostigmine dispelled the muscle paralysis induced by curare. From that time on, numerous investigations have revealed other types of anti-curare agents.

There are two major mechanisms by which these agents may oppose the action of curare: a direct competition between the antagonist and curare at the site of action, or a direct competition between curare and endogenous acetylcholine accumulated as a result of cholinesterase inhibition.

There are no effective antidotes to those agents which act by depolarization, but when true curarizing substances, acting by competitive inhibition are used, neostigmine is an efficient antagonist.

Neostigmine is twice as effective as physostigmine as an antidote and has less parasympathetic activity. Therefore, it is preferable.

Neostigmine and physostigmine antagonize curare because of their strong anticholinesterase property, thus permitting acetylcholine to be a better competitor at the cholinergic receptors in the neuromuscular junction. They also are mild competitors at the end plate, with curare, for the cholinergic receptors.

When using neostigmine 5 points should be remembered:

(1) Atropine must always be given before neostigmine.

(2) Atropine should be administered intravenously at least two minutes before neostigmine.

(3) When vagotonic anesthetic agents, such as Cyclopropane are used, or when the patient has some vagotonic diathesis, such as asthma, inject neostigmine cautiously, in small repeated doses.

(4) Care must be taken to ensure that the respiratory inefficiency is due to the relaxant drug, not to central depression.

(5) It should not be given until the patient exhibits signs of some respiratory activity; otherwise there is no method of grading the effects and the possibility of passing from one form of paralysis to the other exists.

Simple quaternary ammonium compounds have been demonstrated to possess anti-curare action. Tensilon is 3-hydroxyphenyl-dimethyl ethyl-ammonium chloride. It produces its main anti-curare effects by competition at the cholinergic receptors in the neuromuscular junction with curare with consequent displacement of curare. It has a direct stimulating effect upon the muscle through its action on the end plate. It has brief action. It also has mild anticholinesterase activity. It has the advantage of prompt and positive anti-curare action with minimal muscarinic effects.

The five precautions mentioned for the use of physostigmine should be followed when giving tensilon.

Prolonged Apnea

Unexpected persistent apnea has been one of the most annoying complications of the use of muscle relaxants. At first it was believed to be due to a latent myasthenia gravis. However, with the introduction of decamethonium and succinyldicholine the occasional abnormal respiratory depressions continued to occur. It has occured following all commonly used relaxant drugs irrespective of chemical configuration, mode of action at

neuromuscular junction, and mechanisms of detoxification. It has no relationship to age, physical condition, amount of drug used or duration of anesthesia. A number of apneas have followed surgery of the gastro-intestinal tract and patients with abnormal livers, though these are not consistent findings.

There has been no satisfactory explanation, though many theories have been offered, to account for this abnormal respiratory response.

An overdose of anesthetic drug, or a wide fluctuation in blood carbon dioxide level may depress the activity of the respiratory center. In this case there would be no connection with the muscle relaxant used; a determination of CO_2 tension of the blood would give significant information for the treatment of this type of apnea.

A reduced serum pseudocholinesterase activity may have some relationship. Succinyldicholine is hydrolyzed in two stages: one molecule of choline is quickly split off leaving succinylmonocholine. In the second state which takes place more slowly, succinylmonocholine is hydrolyzed to succinic acid and choline. The process of hydrolysis is controlled by the enzyme pseudocholinesterase. Therefore, a low plasma cholinesterase may lead to a slower breakdown to the monocholine derivative which, in itself, has a longer acting muscle relaxing effect. This is found in liver damage, under nutrition, cachexia, and anti-cholinesterase drugs, but also may occur in an otherwise normal person.[4]

The administration of two drugs with similar action on the myoneural junction may lead to persistent apnea; for example, ether and d-Tubocurarine or C10 and Neostigmine.

Another theory is that prolonged apnea may be due to presence of a dual block. It is possible that the end plate response of normal subjects may change under persistent bombardment from one of pure depolarization to one of dual response. This may explain why an apnea following succinylcholine or decamethonium may occasionally be reversed by neostigmine or tensilon.[5]

Respiratory acidosis could be a contributory factor. With inadequate ventilation, alterations in myoneural function may occur leaving a system susceptible to concentrations of a blocking agent which would otherwise produce little effect. Other possible mechanisms involved are central depression or dissociation, potassium deficiency, changes in blood flow to muscles, and delayed renal excretion such as in hypotension and hypothermia.

The treatment of prolonged apnea can only be empirical until the cause can be definitely advanced. Adequate ventilation should be maintained throughout the period of muscle relaxant effects. Central depression or altered CO_2 tension of the blood should be corrected. A plasma cholinesterase determination may be of some value. However, the use of cholinesterase preparations during the period of inadequate ventilation does not seem to help in most cases.

Converse and Boba have successfully treated prolonged apnea with large doses of nikethamide (Coramine).[4] However, their results have not been duplicated by other anesthesiologists.

The intravenous injection of 10-mgm. of Tensilon will elicit the possible presence of a dual block.. Tensilon is preferable to Neostigmine,

because it lasts only a few minutes and if the block is one of pure depolarization, then it would be potentiated briefly, whereas a dual block would be completely reversed.

Prolonged apnea remains a most distressing complication. Because it occurs more frequently following succinylcholine, I prefer to use other muscle relaxants, usually metubine, during abdominal operations.

Summary

Research on the subject of muscle relaxants continues very actively both in the laboratory and in clinical practice. The present day picture may quickly change with the introduction of drugs with more specificity of action and with less physiologic trespass than those used today.

A cursory review of the muscle relaxants is timely. It includes a discussion of mechanism of action, drugs in common clinical use, anti-curare agents, and prolonged apnea.

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General Anesthesia for Tonsil and Adenoid Surgery

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Detroit

General anesthesia for tonsil and adenoid surgery creates certain problems which tax the ingenuity and skill of the most seasoned anesthetist. As in the management of all anesthesia, knowledge of the pharmacology of the drugs employed and the physiologic response of the body to the anesthetic agents is fundamental to the success of the case. With respect to anesthesia for the removal of tonsils and adenoids however, the problems are unique ones.

In surgery for the removal of tonsils and adenoids, the subject as a rule is an apprehensive youngster at a psychologically tender and impressionable age, usually between three and eight years old. In general, the younger the child, the more unreasonable are his reactions to the stress situation, and by the same token, the more pronounced is his state of reflex irritability. In addition, the surgery per se offers a challenge to both surgeon and anesthetist, for it involves the excision of highly vascular lymphoid tissue from the oral and nasal pharynx which is an area not only relatively inaccessible but also replete with abundant secretions.

The problems which arise in connection with anesthetizing a child for the removal of tonsils and adenoids may be considered under two general headings: (1) Pre-anesthesia management of the child, and (2) Technique for administration of the anesthetic. The purpose of this paper is to present a brief and comprehensive discussion of the major factors associated with these problems.

I. Pre-anesthesia Management of the Child

The state of reflex irritability of a patient determines the amount of drug necessary to effect the induction and maintenance of good anesthesia in any instance.[1] The state of reflex irritability is reflected in the metabolism of the patient and is influenced by such factors as age, fear, pain, fever, endocrine imbalance, and emotional instability.

Fear is probably the greatest single factor contributing towards the heightened state of reflex irritability, and in turn the increased metabolic rate, exhibited by the ordinary healthy youngster admitted electively to the hospital for tonsil and adenoid surgery. Apprehension which pos-

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sesses most children under the circumstances to a greater or less degree, is easily recognized in the obviously frightened child who may early display violent reactions even at the idea of being separated from his parents overnight. Apprehension is also present, though not readily apparent, in the stoical individual who is secretly terrified at the prospect of being rendered unconscious in order to have his tonsils removed.

Apprehension is significant not only for the immediate surgery but also for the future welfare of the child in certain cases. In the average child, uncontrolled fear is capable of prejudicing the induction period and precipitating a chain reaction which can complicate the entire operation. In very sensitive patients moreover, a traumatic experience at induction time may also reveal itself in subsequent fears and obsessions and can thus serve to jeopardize the emotional development of these children. Fortunately, the practise of some rudimentary principles of psychology preoperatively and the proper prescription for pre-anesthesia medication will help allay the fears of most children undergoing tonsil and adenoid surgery.

On the evening prior to surgery, the anesthetist should visit his new charge and try to get as well acquainted with the youngster as the limits of time and mutual personalities will allow. Hence on the next morning, his little friend will at least be able to recognize one familiar face amidst the bewilderment of the operating room. A few moments should again be spent reassuring the child before placing him on the operating table. Then the successive steps leading up to the induction should be explained in simple and honest terms beforehand. This approach calls upon the anesthetist's reserves of kindness and patience, but the rewards amply justify the efforts by helping to reduce psychic tension and to gain the confidence and cooperation of the child.

The value of pre-anesthesia medication cannot be overemphasized.[2] Its advantages far outweigh its disadvantages such as the nausea and vomiting frequently observed postoperatively. Judicious premedication will reduce fear and anxiety, lower the metabolic rate, and minimize the secretions of the salivary glands and upper respiratory tract. It serves thereby to ease the induction and maintenance of anesthesia and to prevent respiratory obstruction during anesthesia and respiratory complications after anesthesia.

On the evening before surgery, a therapeutic dose of a barbiturate (elixir of phenobarbital) should be given at bedtime for psychic sedation to help secure a calm night's sleep. Neither food nor drink should be taken after midnight and this order must be strictly supervised when the child awakens in the morning in order to ensure an empty stomach before operation. On the morning of surgery, a mild opiate (codeine sulfate) and a parasympathetic depressant (atropine sulfate) should be given in a single combined intramuscular injection about one hour before induction time. Codeine has approximately one-quarter the potency of morphine and is preferred in children to allay apprehension and lessen reflex irritability. Atropine is used to reduce or abolish secretions of saliva and mucous and to minimize the danger of vagal reflexes. Dosage of medications is determined by body weight and not on the basis of age.

II. Technique for Administration of the Anesthetic

Open drop ether is widely recommended for children because it is the safest anesthetic, it achieves good muscular relaxation, and it does not require that a mask be strapped to the child's face.[3] Open drop vinethene is used in combination with ether to facilitate the induction by circumventing the child's initial resistance to ether. Vinethene alone is undesirable for tonsil and adenoid cases because its rapidity of action makes an even depth of anesthesia very difficult to maintain and the persistence of its toxic effects contraindicate its utilization for procedures requiring more than several minutes of operating time. Once the body tissues have become adequately saturated with ether and the desired level of anesthesia has been reached, the mask is removed and the child is maintained on ether-oxygen administered by either endotracheal intubation or endopharyngeal insufflation.[4]

Endotracheal intubation offers specific advantages for tonsil and adenoid surgery, especially when the surgeon practises the dissection technique rather than the guillotine operation.[5] Intubation involves the insertion of a lubricated rubber tube into the trachea via the nose or mouth usually with the aid of a laryngoscope. The tube is then connected to an anesthetic machine and a mixture of ether-oxygen is delivered directly to the pulmonary system. With intubation, respirations are unhampered, aspiration of foreign material into the tracheo-bronchial tree is diminished, and the depth of anesthesia is more easily controlled.[6] However, there are certain disadvantages to intubation, primarily the instrumentation required by this procedure. Considerable trauma can be inflicted upon the tissues unless intubation is performed by expert hands. Furthermore, some surgeons object to the presence of the tube in the pharynx as an interference within the operative field.

The alternative to endotracheal intubation is endopharyngeal insufflation wherein ether is vaporized in a stream of air inside a special insufflator machine. The mixture is passed into the pharynx via a metal hook hung from one corner of the mouth while oxygen is delivered from a second hook hung from the other corner of the mouth. The chief advantage of this method is its simplicity. Endopharyngeal insufflation may be recommended for routine use by student-anesthetists in small children undergoing tonsil and adenoid surgery except in those patients where a good airway cannot be obtained without resorting to intubation.

In order to achieve satisfactory results with inhalation ether anesthesia, several interrelated factors deserve major consideration: (1) maintenance of good air exchange; (2) aspiration of foreign material; and (3) depth of anesthesia.

Maintenance of Good Air Exchange

Strict attention must be paid to the maintenance of good air exchange during the entire administration of the anesthetic—from the induction period until the patient recovers consciousness. The head and neck should be properly positioned on the table and the lower jaw should be held forward with the chin pointed upward in order to prevent the base of the tongue from falling backward against the posterior wall of the pharynx. Partial or complete obstruc-

tion of the glottis by the tongue can often be avoided by the insertion of a pharyngeal airway as soon as the patient can tolerate one; this is usually in low first plane of stage three where the pharyngeal or gag reflex is abolished. While surgery is in progress, the tongue should be retracted by engaging its dorsum with an L-shaped metal tongue depressor and holding the tongue in a forward position. At the end of surgery, the pharyngeal airway should be re-inserted if necessary and kept in place until the musculature of the jaws regains its normal tonus.

The second stage of anesthesia is known as the period of excitement or delirium and can be troublesome with regard to maintenance of good air exchange. During this stage, an even drop of ether should be continued and as little restraint as possible exercised upon the child without sacrificing firm, manual support of the chin. In this fashion, the anesthetist can usually manage to guide the patient through this provocative period without serious incident.

Ether is the worst offender amongst inhalation agents with respect to laryngospasm. Although it is rarely fatal in the average case, laryngospasm can only be endured momentarily. In a complete spasm, the adductor muscles of the vocal cords shut tight, the lungs cannot be inflated, apnea occurs, and death may ensue within a matter of minutes unless treatment is instituted at once. Management of this condition requires immediate cessation of the anesthetic agent, delivery of oxygen under slight pressure, and a modified Trendelenburg position until the respirations return to normal. Partial spasm may be recognized by a crowing or grunting sound upon inspiration and can sometimes be corrected by deepening the anesthesia. An incomplete but prolonged laryngospasm, however, can cause serious permanent damage to the nervous spstem as a consequence of hypoxemia to the sensitive cerebral cortex.[7]

Special efforts must be taken to preclude a laryngospasm at the time of transfer from open drop to endotracheal insufflation. The level of anesthesia should first reach middle second plane of stage three so that the cough reflex will have been obliterated before the shift is made from mask to insufflator. Otherwise the sudden stream of ether vapor directly upon the exposed cords may prove too irritating and cause a spasm. As added precaution upon introduction of the mechanical mouth prop, the jaws should be separated slowly by gradual expansion of the prop. Simultaneously, insufflation is begun and the volume of ether vapor is increased carefully by degrees to allow the glottis to accomodate itself to the flow of ether vapor. Once the anesthetist is assured that the child can tolerate the concentration of ether without difficulty and that the desired depth of anesthesia has been obtained, the surgeon may proceed with the operation.

Aspiration of Foreign Material

Aspiration of foreign material such as vomitus, mucous, and blood into the trachea and lungs is of vital concern in tonsil and adenoid surgery. Prevention of aspiration of debris from any source depends on close cooperation between both surgeon and anesthetist to help minimize the incidence and severity of this complication.

The vomiting reflex appears at the junction of stages two and three and

can occur during the descending and ascending phases of anesthesia. Vomiting is more easily avoided in descending anesthesia and its prevention can be accomplished by carrying the patient rapidly through the excitement period into the surgical level. During maintenance, vomiting can be prevented by administering the anesthetic smoothly and by avoiding a return to the second stage. In this regard, the swallowing reflex which appears at upper border plane one of stage three is a good indicator that vomiting is imminent if the patient should lighten up any further.

During emergence from anesthesia, the vomiting reflex is more difficult to avoid and should be anticipated. Whether the child is on the operating table or back in bed, protection against aspiration of vomitus in the ascending phase requires that the head be kept on its side to favor drainage from the mouth and that the suction apparatus be at hand continuously to remove debris the instant it is regurgitated.

Ether is foremost amongst inhalation agents for stimulating hyperactivity of the secretory glands of the respiratory tract. Unless adequate premedication is given, abundant mucous will be secreted, especially during the induction period. These secretions can interfere with normal gas exchange through the alveolar membrane of the lung, predispose the patient to hypoxemia, and render the anesthesia much more difficult to control. Excessive secretions should be promptly suctioned out of the oral cavity in a swift and gentle fashion in order to prevent aspiration into the trachea and lungs.

Some degree of aspiration of blood into the lungs is unavoidable in surgery for the removal of tonsils and adenoids and may be responsible for the formation of small pulmonary abscesses. The operative field can be kept reasonably dry during the procedure by vigilant suctioning of blood, gauze pressure against oozing capillaries, and immediate ligation of severed vessels. There is always the danger that a large blood clot may be formed in the posterior pharynx, become dislodged and then aspirated into the trachea causing a complete obstruction of respiration. As a means of preventing such clot formation, and in order to safeguard the child against the possibility of a serious or even fatal post-operative hemorrhage, the surgeon must conscientiously arrest all bleeding points in the tonsillar areas and nasopharnyx before the operation is concluded.

Depth of Anesthesia

The best indicator of the depth of anesthesia is the nature of the respirations. Eye signs are not reliable guides to anesthesia but may have value if the effect of the premedication on the pupils is taken into account. The anesthetist must be familiar with the pattern of breathing associated with the various stages and planes of ether anesthesia. Observation of the rate and volume of the respirations enables the anesthetist to regulate the anesthesia at the desired level for the particular patient undergoing surgery.

There are two opinions regarding the ideal level of surgical anesthesia at which to maintain a child under endopharyngeal insufflation for tonsil and adenoid surgery. One school of thought prefers middle second plane of stage three where the laryngeal or cough reflex is abolished; the other school requires only low first

plane of stage three where the tongue muscles are inactivated but the cough reflex is still retained. At the deeper level, the operative procedure is facilitated due to relaxation of the throat muscles. However, there is a greater tendency for aspiration of blood and debris into the trachea and lungs at the deeper level than when the child is maintained in the lighter plane of surgical anesthesia.

Summary

Surgery for the removal of tonsils and adenoids is a major experience in the life of a child and the anesthetist assumes a big responsibility in undertaking to anesthetize the young patient. Successful general anesthesia depends on proper preanesthesia management of the child and good technique for administration of the anesthetic.

Management of the child prior to surgery is concerned with reducing apprehension, lowering the metabolic rate, and minimizing the secretions of the salivary glands and respiratory tract. A sound psychological approach to the child together with adequate preoperative medication will usually accomplish these objectives and help ensure the smooth induction and maintenance of anesthesia.

Inhalation ether is the safest anesthetic drug to employ in children undergoing removal of tonsils and adenoids. Vinethene-ether is administered by the open drop method for the induction period. Endotracheal intubation with ether-oxygen is ideal for the maintenance of anesthesia but should only be utilized by experienced personnel. Endopharyngeal insufflation with ether-oxygen is recommended for routine use by student-anesthetists except in children where a good airway cannot be obtained without intubation.

Important factors associated with inhalation ether are maintenance of good air exchange, aspiration of foreign material, and depth of anesthesia. Attention to these considerations will help prevent complications which could jeopardize the anesthesia and prejudice the surgery.

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3. Adriani, John: Pharmacology of Anesthetic Drugs, 3rd edition. Charles C Thomas, Publisher, Springfield, Illinois, 1954, pp. 32-38.

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Notes and Case Reports

A Constant Monitoring System

Recently, various types of apparatus have been devised for constant monitoring of anesthetized patients' heart sounds and blood pressure. The device, shown in Figure 1, is an inexpensive, easily assembled apparatus to provide for this. It was introduced to me by Dr. William M. McKay, Major, USAF (MC), 2750th USAF Hospital, Wright-Patterson AFB, Ohio.

The following steps are taken in utilizing the monitoring device:

1. Affix the stethoscope to the patient's arm in the usual manner with adhesive tape.

2. Affix the 2nd chest piece type stethoscope with adhesive tape over the left anterior chest about 2″ medial to the left nipple.

3. Pin the extension from the three-way stopcock to dress and comfortably place ear defender® in ear.

When assembling this portion of the apparatus, first wrap a 3/4″ x 1½″ piece of adhesive tape around the end of Venatube®; THEN SLIT INNER SURFACE OF EAR DEFENDER® with a Bard Parker® blade, to allow this end of Venatube® to pass through it and rest securely, flush with the outer surface of ear defender®.

The apparatus will allow constant monitoring of patient's heart sounds and blood pressure. The straight path-

(Continued on page 83)

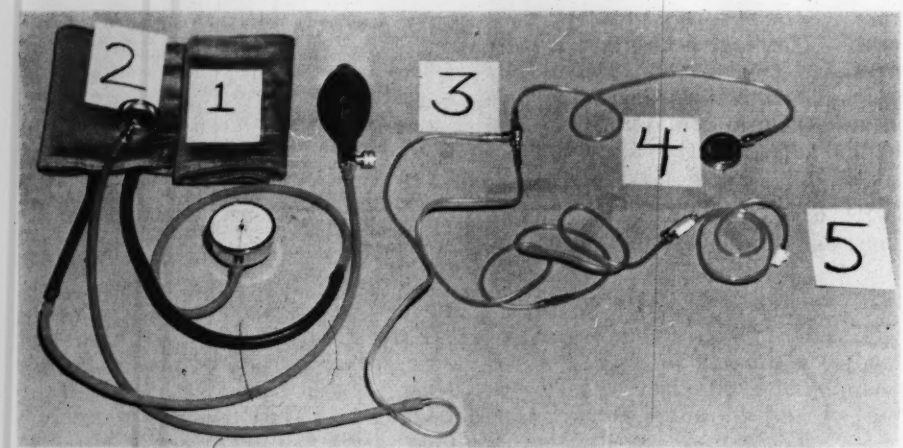

Figure 1.—A Constant Monitoring System. 1. Standard "wrap around" type blood pressure cuff, 2. Chest piece type stethoscope, from which diaphragm has been removed, and diaphragm retaining ring replaced, 3. Three-way Stopcock, 4. Chest piece type stethoscope, to affix to patient's (Armed Forces Medical Stock List Catalog #6515-299-8288, etc.). The plastic tubing photographed is "used" Venatube®; however, improvisations may be made here.

(Official USAF Photo)

Legislation

Emanuel Hayt, LLB., Counsel A.A.N.A.

JURY ENTITLED TO DETERMINE WHETHER NURSES BECOME SURGEON'S EMPLOYEES IN OPERATING ROOM — J. Hogan Benedict, a three year old child, became seriously ill one evening and was rushed the next day to the McKeesport Hospital where an emergency operation was performed by defendant Dr. Frank R. Bondi. Mrs. Jean Streigel Waddell, also a defendant, was then a student nurse at the hospital working in and about the operating rooms. She testified that she did not remember the Benedict boy being brought into the room or that he told her to give the bottles to Mrs. Irma Bieda, another of the defendants, to put on the child. Mrs. Bieda, who was a graduate nurse and was then on general duty in the operating room, testified that Dr. Bondi told her to apply the bottles, so she placed them on the outer sides of the child's feet; that as soon as the anesthetist said that the child was completely under—which was about three minutes after the hot water bottles had been placed—Dr. Bondi began the actual incision; that in and out of the operating room were several nurses and that an assistant to the surgeon and a number of spectators were also present. It was testified that after the operation was over (which proved ultimately to be successful) the child was taken to his room in the hospital whereupon the floor nurse discovered that his feet were badly burned; a later examination disclosed that he had suffered third degree burns with destruction of the subcutaneous tissue down to the bone. There was testimony that the water in the bottles should not have been of a temperature greater than 115 or 120 degrees, but that, in order to have caused the injury it produced, it must have been at the 212 degree boiling point.

The only question now in issue is the liability of Dr. Bondi for alleged negligence of the nurses in the application of the hot water bottles to the child's feet. Certainly it is true that a nurse's activities in preliminarily cleaning the operating room, placing clean sheets on the operating table, preparing gowns and gloves, sterilizing the instruments to be used in the operation and seeing that they are available for the purpose, making ready the sterile drapes, placing the patient on the operating table—all these are administrative or ministerial acts performed by the nurse as an employe of the hospital and in regard to which the doctor or surgeon has not yet — to use a colloquialism — "come into the picture." But here the jury might have found from the testimony that the application of the hot water bottles to the child's feet was not merely an administrative act of the nurse similar to her performance of such other functions but a medical or therapeutic act (see Hayt, Hayt & Groeschel, "Law of Hospital, Physician, and Patient", 2nd ed., p. 385);

that such an application is not a routine matter in all operative procedure but is sometimes employed where the patient is in shock; that it is therefore a decision for the surgeon to make and for him to determine and direct if, when and how heat should be applied; that Dr. Bondi not only had the complete authority and control in the operating room as to which Dr. Corsello testified, but that he actually gave orders to the one nurse, the student nurse, not to apply the hot water bottles to the child; and orders to the other nurse, the graduate nurse, to do so; and therefore, as the result of such findings, that his legal responsibility did not begin merely at the exact moment when he started to make an incision in the child's body but that the operative process started with, and included, the application to the child—in the operating room and under the eye of the surgeon—of the hot water bottles designed, as they were, to assist in the rehabilitation and restoration of the patient's strength, health and well-being. If the jury found that such were the facts it would follow that Dr. Bondi would be liable for Mrs. Bieda's alleged negligence and that therefore a nonsuit as to Dr. Bondi should not have been entered.

The order of the court below removing the nonsuits as to defendants Jean Streigel Waddell and Irma or Erma Bieda is affirmed. The refusal of the court to remove the nonsuit as to McKeesport Hospital is affirmed. The refusal of the court to remove the nonsuit as to defendant Dr. Frank R. Bondi is reversed, and plaintiffs are granted a new trial as to defendants Jean Streigel Waddell, Irma or Erma Bieda, and Dr. Frank R. Bondi.

(Benedict v. Bondi, et al., 5 CCH Neg. Cases 2d 1024 - Pa.)

Loss Of Teeth During Tonsillectomy Not Proved Caused By Malpractice — Jane Craig Fields, acting by her father as next friend, sued Dr. Charles C. Rutledge for $25,000 damages alleged to have been sustained by her by reason of his malpractice in performing a tonsillectomy. The jury returned a verdict for defendant and on appeal plaintiff insists the court erred.

On April 19, 1954 defendant performed a tonsillectomy on Jane, who then lacked four months of being 7 years of age. The operation was performed in the Methodist Hospital in Pikeville and the child was given a general anesthetic. A device known as a "Davis mouth prop, or gag" was used to hold Jane's jaws apart and to keep her tongue depressed during the operation. It is the customary instrument used in such operations where a general anesthetic is given, and consists of a metal frame with rubber pads which rests against the teeth. After one tonsil is removed the "mouth prop" is loosened and shifted in the mouth and again fixed against the teeth so the surgeon will have access to the other tonsil.

When defendant removed the first tonsil and was shifting the "mouth prop" he noticed the two upper front teeth, or incisors as they are called, were so loose as to be pratically out and he removed them with his fingers. He discarded the "mouth prop" and completed the operation by using a tongue depressor.

Counsel for plaintiff in their brief say the doctrine of res ipsa loquitur generally applies to a physician or surgeon when he gets beyond the field of the operation and injures some sound portion of the patient's body not involved in the operation. However, as the trial court submitted the case to the jury without plaintiff

proving any negligence on the part of defendant and as the jury found for defendant, we deem it unnecessary in the circumstances of this case to discuss or pass upon the question of whether or not res ipsa applies.

(Fields v. Rutledge, 284 S.W. 2d 659 - Ky.)

Hospital And Nurse Not Responsible For Hemostat Left In Patient's Abdomen — Plaintiff brought action to recover for malpractice. It was shown that a hemostat six inches long had been left in her abdomen during an operation. Defendants were those who had performed or assisted in the operation and the hospital. Plaintiff settled her action with some of those involved, and at the close of her evidence the court granted judgments of nonsuit in favor of one of the surgeons involved, the surgical nurse, and the hospital. Plaintiff appealed contending that she was entitled to maintain her action against all persons involved in the negligent operation. This court held that an inference of negligence arose against those involved in the operation by the application of the doctrine of res ipsa loquitur. Such an inference of negligence was rebutted in the present case, however. The uncontradicted evidence showed that those discharged of liability were in no way connected with the accident. It was shown that the hemostat had been left in plaintiff prior to the time defendant surgeon was called to assist in the operation because of an unexpected circumstance which required the extension of the operation to a distant second field. Defendant surgical nurse was not responsible because of a negligent count on clamps. It was shown that the nurse's duty was simply to account for sponges and needles. Defendant hospital was properly discharged since its employee was not negligent. The judgment of the trial court was affirmed.

(Leonard v. Watsonville Community Hospital et al., 5 CCH Neg. Cases 2d 870 - Calif.)

New Trial Ordered For Patient Left Unattended In Bathroom Of Hospital — Plaintiff, a patient in defendant's hospital, sustained injury when she fell while unattended in a bathroom and she brought suit to recover damages for injuries so sustained. Her evidence indicated that she had been operated upon for hernia of the anus, and that for this purpose a spinal anesthetic had been administered. Some three hours after the operation plaintiff summoned a nurse and informed her that she wished to relieve herself, that she had to go to the "bathroom." The nurse assisted plaintiff from bed and to a nearby bathroom where the nurse saw her safely seated on the commode. Since the nurse was busy and had to leave, plaintiff was instructed to holler when she had finished. Plaintiff thereafter became dizzy and frightened; she got off the toilet, seated herself on a bathtub and rested her head in her arms against a wash basin. She then called her husband who was outside the bathroom, and at that moment plaintiff fell to the floor sustaining the injuries for which she brought this suit. The lower court was of the view that plaintiff's evidence failed to show a departure from a standard of ordinary care on the part of defendant and that plaintiff was contributorily negligent as a matter of law. On appeal this court held that, on the record presented, plaintiff was wrongfully deprived of the right to go to the jury. Whether defendant was negligent in failing to provide plaintiff a bed pan and in

(Continued on page 83)

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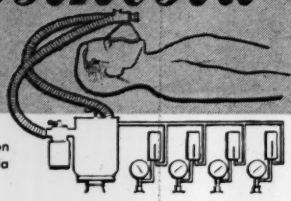


Gas Pressure Regulators

There are two distinct types of gas pressure regulators.These are called "direct" and "indirect" regulators, the distinction lying in the direction in which the unregulated or inlet pressure is exerted upon the regulator valve. That type of regulator in which the closure of the valve is opposed by the inlet gas pressure is called the "direct" type, and that in which the closure of the regulator valve is assisted by the unregulated or inlet gas pressure is called the "indirect" type. Both types fulfill the same function as set forth in the above definition but differ in details of their operation.

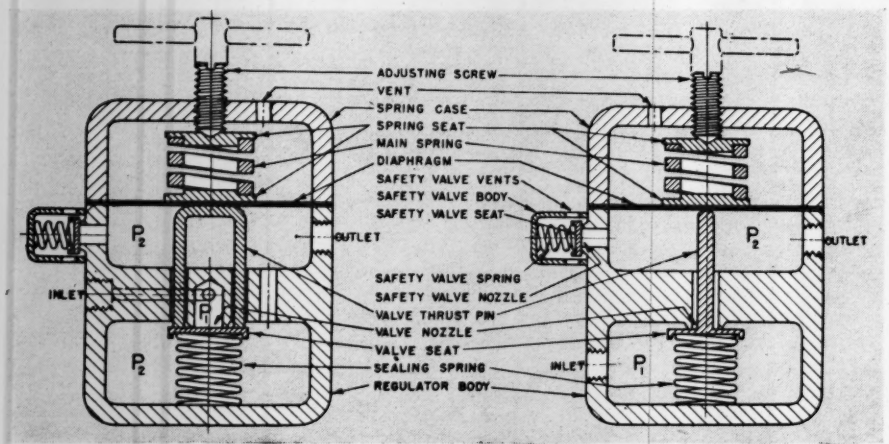
A regulator may be regarded as a mechanism which is perpetually striving to achieve a balance between several changing forces. These forces, all mechanical in nature, may be exerted by weights, springs, levers, gas pressures, friction or nearly any other means either individually or in combinations. The operation of a regulator is limited in the degree to which it can achieve a balance between these forces and the range of flow and pressure over which such balance can be achieved.

STATIC BALANCE

Direct Type (See Fig. "A") The drawing shows only the essential parts of the regulator. The adjusting screw in the spring case is designed to compress the main spring between the two spring seats, forcing the lower spring seat against the diaphragm.

The diaphragm is a thin, flexible, gas-tight membrane which transmits this spring load to the valve thrust pin. The latter is guided vertically in the regulator body so that its lower end bears against the valve seat, which is biased against the nozzle by the sealing spring. Let us assume that the adjusting screw has been turned to release the load in the main spring, allowing the sealing spring to seal the valve seat against the valve nozzle, and that the inlet of the regulator is connected to a source of gas under high pressure through a valve which is closed. Let us further assume that the outlet is fitted with a valve which is likewise closed.

When the valve between the source of high pressure gas and the regulator inlet is



DIRECT TYPE Fig. A

INDIRECT TYPE Fig. B

opened, the gas under this pressure, which we shall call P1, will enter the inlet and pass through a hole into a cavity above the valve nozzle, exerting a force on the valve seat which tends to open it. (The inlet hole does not connect with the thrust pin guide holes.) This force is more than counterbalanced by the force of the sealing spring tending to close the valve. The difference between these two forces equals the actual load which is applied to the rim of the valve nozzle by the valve seat.

Let us now turn the adjusting screw to compress the main spring against the diaphragm. When this compressive force has exceeded the force which the valve seat exerted on the valve nozzzle after the gas was admitted to the inlet, the valve seat will move away from the valve nozzle, permitting gas to expand between them into the cavity surrounding the sealing spring as well as through the valve thrust pin guide holes shown, and into the space below the diaphragm. Here it will be trapped and will increase in pressure until it exerts enough force on the diaphragm opposing the force of the main spring to permit the sealing spring to seal the valve seat against the valve nozzle, at which point no more gas will flow through the valve and the regulator will have reached a condition of static equilibrium.

Indirect Type (See Fig. "B") This type is identical with the direct type down to and including the diaphragm, below which the valve thrust pin projects through a hole terminating in the valve nozzle and carries on its lower end a valve seat which is biased in the direction of the valve nozzle by a sealing spring.

Let us postulate the identical starting conditions as used above with the Direct Type. Then, when the valve between the regulator and the high pressure source of gas is opened, the gas will enter through the inlet into the cavity surrounding the sealing spring and valve seat but will go no further. In this case its own pressure P1, distributed over the area of the valve nozzle, assists the sealing spring in keeping the valve closed.

Turning the adjusting screw to cause the main spring to exert a load on the diaphragm will eventually result in a main spring force exceeding the total of the sealing spring force and the force due to the pressure of the inlet gas over the area of the valve nozzle. Under these conditions the valve seat will move away from the valve nozzle, allowing the gas to expand through the nozzle along the valve thrust pin and into the cavity under the diaphragm. Here it will be trapped and will increase in pressure until it exerts a force on the diaphragm which, in combination with the forces of the sealing spring and the inlet pressure, will lift the diaphragm against the force of the main spring to permit the valve seat to seal against the valve nozzle, stopping further flow and introducing the condition of static equilibrium.

Note: This is an abridged version of an article on this topic by Wayne Hay, Product Design Engineer. For a copy of the complete article, kindly write Dept. A.I.—NA.

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(Continued on page 79)

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5. Are you now to the best of your knowledge and belief in good health and free from any physical impairment or disease? Give details of all exceptions:

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	56-60	16.50	31.35	59.40
	61-65	19.80	37.60	71.30
( ) PLAN B $150 MONTHLY BENEFIT	16-55	19.80	37.60	71.30
	56-60	24.75	47.00	89.10
	61-65	29.75	56.45	107.15
( ) PLAN C $200 MONTHLY BENEFIT	16-55	26.40	50.20	95.00
	56-60	33.00	62.70	118.80
	61-65	39.60	75.20	142.60

IMPORTANT! Members earning less than $2,500 may enroll in Plan A only.

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Members earning $3,000 or more may enroll in Plans A, B or C.

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Ages 61-65	8.30	15.80	29.90

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Book Reviews

Dynamic Psychiatry in Simple Terms. By Robert R. Mezer, M.D., Senior Staff Psychiatrist, Community Clinic, Massachusetts Mental Health Center and Harvard Medical School. Paper. 175 Pages, illustrated. Springer Publishing Co., New York, 1956. $2.50.

The author who for many years has lectured to medical students, student nurses and other groups has utilized his experience in presenting simplified theories and observations in "plain English" for persons who are dealing with the psychiatric patient and in understanding normal and abnormal behavior. The book is concluded by an essay on "The Normal Life" which chapter in itself would seem to justify the existence of the book without the valuable information contained in the main body of the text. Indexed and illustrated.

Obstetrical Anesthesia. Its Principles and Practice. By Bert B. Hershenson, M.D., Director of Anesthesia, Boston Lying-in Hospital; Clinical Associate in Anesthesia, Harvard Medical School. Cloth. 406 Pages, illustrated. Charles C Thomas, Publisher, Springfield, Illinois. $9.50.

The medical student, the general practitioner, the obstetrician in training and the occasional anesthetist are among those who are called upon to administer anesthesia to the obstetric patient. It is the authors intent in publishing this book to "offer a rational answer to many of the problems presented to all of those persons who have the responsibility of improving the practice of anesthesiology as applied to the obstetric patient."

A rather thorough historical background precedes the clinical text. Each paragraph is followed by a lengthy list of references and the book is well indexed. This would seem to be a most valuable book for persons who are administering anesthesia to the obstetrical patient or to those who are teaching in the field of anesthesia.

Anesthesia for Surgery of the Heart. By Kenneth K. Keown, M.D., Associate Professor of Anesthesiology, Hahnemann Medical College and Hospital, Philadelphia, Pennsylvania. Cloth. 109 Pages, illustrated. Charles C Thomas, Springfield, Illinois. $3.75.

The subject of anesthesiology as it deals with surgery to correct both congenital and acquired cardiac abnormalities has been presented by the author on the basis of knowledge gained in ten years of experience in an active cardiac surgical center. Emphasizing the necessity of team work, the author has given a brief summary of the development of cardiac surgery ending with an incomplete list of surgeons and anesthesiologists who have contributed to the present status of cardiac surgery. The selection and evaluation of the patients occupies the first portion of the clinical text, preliminary medication and anesthetic management each being the subject of short chapters. Cardiac irregularities which should be known to the anesthetist, complications during anesthesia and postoperative management are discussed in a general way. Specific cardiac abnormalities and their surgical treatment are each discussed with specific suggestions for management. The author has suggested a few of the developments that may be anticipated in the future for the continued success of cardiac surgery. This book is not indexed; 115 references are included in the bibliography. This is another of the monographs in the American Lecture Series that will be found useful to persons who are practicing anesthesia for this special type of surgery.

Abstracts

GATHERUM, D. H.: Infant resuscitation. Bull. Maternal Welfare 3:17-21 (Sept.-Oct.) 1956.

"Neonatal asphyxia is the major cause of death in the first twenty-four hours of life. Approximately 110,000 infants per year die during these hours .... The pathology of asphyxia is that of anoxia .... Apnea appears in 30 to 60 per cent of babies born to mothers who have been given relief from the pain of labor with narcotics. All general anesthetic agents will produce depression of respiration in the mother, which results in reduced oxygen supplied to the baby. The fetal respiration system is more sensitive to narcosis than the maternal, and no indication of degree of depression of respiration in the fetus can be judged by the reactions of the mother. Depression of respiration in the mother can then produce no other effect on the infant than deprivation of oxygen ....

"Intelligent resuscitation aims at obtaining four conditions: (1) keeping the infant warm (the drop of 29° F. in the baby's environment is in itself quite a shock), (2) a minimum of handling, (3) a clear open airway, (4) oxygenation of the baby's blood stream as soon as possible (within thirty seconds) .... A clear open airway is best obtained by intratracheal intubation and suction through a small rubber catheter .... Oxygenation of the blood stream is the primary purpose of resuscitation. After the cord has stopped pulsating it may be clamped and severed. This prevents depriving the infant of 80 to 200 cc. of blood. Prolonged apnea in the infant produces permanent cerebral damage; oxygen should be administered within thirty seconds of birth ....

"The pressure which may be safely applied is variously described at 18-cm. of water, to as high as 30 cm. of water to 60 cm. of water pressure possible without damage to the lung. Mouth to mouth breathing may be resorted to with positive pressure sufficient to initiate expansion of the chest, then as soon as the chest motion is felt, the resuscitator stops and allows the chest to recoil from its elasticity. Resuscitation may require hours before the infant takes his first spontaneous breath. During this time oxygen must be given as described. The baby who has required resuscitation should be placed in an incubator with oxygen for at least twenty-four hours, with the severely asphyxiated baby requiring special attention for as long as four to seven days ....

"One of the best prophylactic measures to prevent neonatal asphyxia is the administration of oxygen to the mother. Our procedure is to dump the breathing bag contents, fill with pure oxygen and allow the patient to breathe this pure oxygen until she is either too light to continue or until the umbilical cord stops pulsating or is clamped .... One-hundred per cent oxygen is advocated during all deliveries in which spinal, block or local infiltration anesthesia is used. In those infants who develop a hyaline membrane the minute volume is increased, tidal volume is normal, carbon dioxide is eliminated in normal amount, alveolar ventilation is normal, functional dead space is increased, and an increase in esophageal

pressure is found. This means that many times the normal amount of energy is expended in respiration .... As high as 80 per cent of the infants who have the hyaline membrane diagnosis recover when treated with nothing more than increased oxygen. High humidity also helps these infants."

BANNISTER, W. K.: Controlled respiration during cesarean section. J.A.M.A. 162:1028-1030 (Nov. 10) 1956.

"On strictly scientific grounds, it is easy to condemn the use of general anesthesia in obstetrics because of its adverse effects on the newborn infant .... In order to study the depressant effects of anesthesia upon newborn babies, a group of patients has been selected in such a manner that causes of depression other than anesthesia might be eliminated from consideration. Injury and distress to the fetus during labor and delivery have been largely ruled out by selecting for study only babies born by repeat or elective cesarean section.

"Three types of anesthesia were administered for the cesarean sections selected for this study. Group 1 included 96 mothers who received spinal analgesia. Tetracaine (Pontocaine) hydrochloride and procaine were the agents used for all patients. Eleven of the mothers of this group received thiopental (Pentothal) sodium to allay anxiety. The largest amount of thiopental sodium given to any mother before delivery was 200 mg. Group 2 consisted of 165 mothers who received general anesthesia, during the course of which spontaneous respiration was maintained. The agents employed were thiopental sodium, 100 to 150 mg., for induction followed by inhalation of cyclopropane and oxygen .... Tubocurarine chloride given in doses of 6 to 9 mg. was an aid in maintaining relaxation, in spite of light planes of anesthesia, and was used for all except three patients in this group ....

"Group 3 was composed of 157 mothers who received the same agents employed for group 2. The anesthetic technique was modified, however, to allow complete manual control of the mothers' respiration. Relaxant drugs were given three or four minutes following induction with thiopental sodium, 100 to 150 mg., in order to improve operative conditions and to insure complete control of respiration. Tubocurarine chloride was administered to 91 mothers in amounts ranging from 6 to 12 mg., and succinylcholine (Anectine) chloride was given to 66 mothers in total amounts ranging from 40 to 120 mg., given in divided doses. As soon as muscular relaxation was obtained, controlled respiration was begun and continued until the baby was delivered. Respiration was controlled by slowly increasing the pressure on the rebreathing bag during inspiration, followed by sudden release of the bag during expiration. A tidal volume of 500 cc. at a rate of 15 respirations per minute was considered to be adequate. An effort was made, and usually achieved, to accomplish hyperventilation in the mothers with an anesthetic mixture high in concentration of oxygen ....

"The incidence and severity of depression in the babies was found to be least when spinal anesthesia was given. The babies delivered of mothers who received general anesthesia and had adequate pulmonary ventilation by controlled respiration had a significantly lower incidence and severity of depression than the babies delivered of mothers who received similar anesthesia but who did not have their respirations ocntrolled. It is postulated that better oxygenation combined with better elimination of carbon dioxide for mothers and babies contributed to this result."

Insurance

(Continued from page 72)

necessary to cancel every policy in force on all the members or change every policy in force on all the members before any individual policy could be touched.

It pays for all sicknesses, all accidents except private flying or in the event of war if you're in the Armed Forces of any country at war. The policy contains many benefits not found in an individual plan. Your AANA Sickness and Accident Policy is the finest. Claims are now being honored regularly in many states. Join your professional association's insurance plan now!

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John Maginnis
Insurance Consultant

The TWENTY-FIFTH QUALIFYING EXAMINATION for membership in the American Association of Nurse Anesthetists will be conducted on May 11, 1957. The deadline for accepting completed applications including the transcripts is April 1. Notice of eligibility will be mailed about April 8.

Classified Advertisements

SECOND ANESTHETIST needed for modern, air-conditioned, fully approved, 70-bed hospital in Southern Illinois, University town. Excellent working conditions. Salary open. Contact Jack Edmundson, Doctor's Hospital, Carbondale, Illinois.

NURSE ANESTHETIST: You will like beautiful Western Pennsylvania 40 miles from Pittsburgh. Fully approved 188-bed general hospital. Attractive personnel policies. Salary open. Write Administrator, Latrobe Hospital, Latrobe, Pennsylvania.

POSITION AVAILABLE: Nurse Anesthetist to complete staff of four in 500-bed 2-year-old hospital. Salary according to experience with annual increases. New equipment and all types of surgery. Take call at home. No scheduled cases on Saturdays. Additional information from Dr. Alfred M. Keirle, Chief, Surgical Service, Veterans Administration Hospital, 3200 Vine Street, Cincinnati 20, Ohio.

NURSE ANESTHETIST: Excellent working conditions. $400 per month with annual increases of $25 per month to maximum of $500. Three weeks vacation, after one year, minimum of two weeks sick leave. Usual employee benefits. Lexington is located in "The Heart of the Bluegrass" famous for horse racing and tobacco industries, home of University of Kentucky and Transylvania College. Apply: Assistant Administrator, Good Samaritan Hospital, South Limestone Street, Lexington, Kentucky.

REGISTERED NURSE ANESTHETIST: For 265-bed fully approved, general hospital. Staff 5 nurse anesthetists, alternate call. Surgery and obstetrics. Three weeks paid vacation, 6 holidays, sick leave. $450 minimum salary, allowance for experience. Send resume of experience to Personnel Director, St. Joseph Hospital, Lexington, Kentucky.

NURSE ANESTHETISTS (two) for expanding services of functionally modern general hospital. Separate anesthesia and recovery rooms. All types of surgery including neuro and chest. Air conditioned five-room suite. City of 95,000 in Michigan's resort area. Minimum starting salary $400 per month (five-day forty-hour week) in addition to attractive call compensation. Personnel Director, 705 Cooper Street, Saginaw, Michigan.

ANESTHETISTS WANTED: Busy suburban hospital near Chicago. Attractive nurses' residence, private rooms. Starting salary $395 per month plus full maintenance. 40-hour week. MacNeal Memorial Hospital, Berwyn, Illinois.

NURSE ANESTHETIST — position open in 134-bed general hospital. Salary and living conditions very desirable. Room, laundry, and insurance benefits furnished in addition to salary. Location on the East Side of St. Paul with convenient transportation to the downtown area. Two other anesthetists on duty with a minimum amount of call. Write E. M. Garnett, R.N., Superintendent, Mounds Park Hospital, 200 Earl Street, St. Paul 6. Minn.

NURSE ANESTHETIST — for 100-bed hospital. New hospital being constructed. Salary open. Apply: Nathan I. Kantor, M.D., Chief of Anesthesia, Warren Hospital, Phillipsburg, New Jersey.

ANESTHETIST. AANA member — male or female — second anesthetist for 44 bed hospital expanding to 99 beds. Fast growing town of 15,000 in Southwest, wonderful climate — 5,000 feet elevation. Starting salary $450 per month. Two weeks vacation, 6 paid holidays, sick leave. Send full particulars to Administrator, San Juan Hospital, Box 1087, Farmington, New Mexico.

ANESTHETIST needed to complete staff of four, 150-bed fully approved hospital in "City of 100 Lakes." Starting salary $450 with $25 increase at the end of one year. All other fringe benefits. Contact: Thomas Richards, Head Anesthetist, Winter Haven Hospital, Winter Haven, Florida.

WANTED: Nurse Anesthetist for 109-bed hospital. Two anesthetists with extra relief anesthetist; no ob. call; alternate weekends off, week day off in alternate weeks. Contact: Mrs. J. E. Lindsey, Administrator, Retreat for the Sick, 2621 Grove Avenue, Richmond, Virginia.

ANESTHETIST — modern, 360-bed general hospital offers the best in facilities and equipment. Excellent working conditions. Liberal salary and other fringe benefits. Maintenance available if desired. Write: Personnel Director, Miller Hospital, St. Paul, Minnesota.

NURSE ANESTHETISTS WANTED: for new Oral Surgery Clinic in vicinity of Altoona and Hollidaysburg, Pennsylvania. Beginning the last of January or first of February, 1957. Dr. Joseph L. Haller, Clinic Building, Logan and Hawthorn Street, Hollidaysburg, Pennsylvania.

WANTED: Nurse Anesthetist, new 200-bed hospital; modern equipment; active department. Apply: Administrator, Bradford Hospital, Bradford, Pennsylvania.

REGISTERED NURSE ANESTHETIST: Excellent working conditions in modern 132-bed hospital. Friendly community with two colleges. Salary open pending qualifications and experience. Apply Ralph B. Bersell, Administrator, Passavant Memorial Area Hospital, Jacksonville, Illinois.

NURSE ANESTHETIST: New and modern surgery; unusually strong and well diversified surgical staff. Good opportunity in new 200-bed expanding hospital; college town location; good personnel policies; 40-hour week; 7 holidays, hospitalization, social security. Apply: F. J. O'Brien, Administrator, Chambersburg Hospital, Chambersburg, Pennsylvania.

WANTED — Lady Nurse Anesthetist. Group of 7 physicians and 2 nurses. Salary open. Contact Albuquerque Anesthesia Service, Medical Arts Square, N.E., Albuquerque, N. M.

NURSE ANESTHETIST: New, modern, 50-bed general hospital; located in town of 6,000; 28 miles from Roanoke, Virginia. Salary open. Apply to: Administrator, Bedford County Memorial Hospital, Bedford, Virginia.

WANTED: Nurse anesthetist for employment in 200-bed accredited hospital in central Pennsylvania. Industrial and farming area. Modern hospital. Department staffed by four nurse anesthetists and certified M.D. Write Administrator, Lewistown Hospital, Lewistown, Pennsylvania.

WANTED: NURSE ANESTHETIST A.A.N.A. membership. Excellent salary and opportunities. Paid vacation. Excellent working conditions. Rotating call every seventh night and seventh weekend. Day off following call. 550-bed hospital. Staff of nine anesthetists. Apartment and full maintenance available. Apply: Miss Mildred Hodges, Chief Anesthetist, Missouri Baptist Hospital, 919 N. Taylor Avenue, St. Louis, Missouri.

WANTED: Nurse Anesthetist, Rural Hospital adjacent to Yellowstone National Park. Excellent recreational area, rare night call, salary open. Apply Adminstrator, St. John's Hospital, Jackson, Wyoming.

NURSE ANESTHETIST: To work in 500-bed Veterans Administration teaching hospital. Qualifications: Graduation from a recognized school of nursing, supplemented by completion of an accredited course in anesthesia. Possession of a license or eligibility in any state required. Salary range $4025 to $6390, depending upon qualifications and experience. For full particulars write to Manager, VA Hospital, 915 N. Grand Boulevard, St. Louis 6, Missouri.

NURSE ANESTHETIST: Male or female. Member of A.A.N.A. or eligible. Starting salary $500.00 per month, with increases to $600.00. One month paid vacation, plus sick leave, uniforms furnished, and laundry. 225-bed hospital in town of 50,000, 40 miles north of Chicago. Moving into new air-conditioned surgery. Emergency call every fifth night. Apply Administrator, Victory Memorial Hospital,, Waukegan, Illinois.

NURSE ANESTHETIST to join obstetrical anesthesia staff. 40 hour week; salary adjusted to experience. Write Administrator, Highland Hospital, Rochester, New York.

WANTED: TWO NURSE ANESTHETISTS, A.A.N.A. members, for 350-bed modern general hospital in Sacramento, California. Salary open, extra for call. Laundry, insurance, 7 paid holidays, vacation. For detailed information write Marion Sleight, Mercy Hospital, Sacramento, Calif.

WANTED: Nurse Anesthetist to work closely with Board certified anesthesiologist in private practice in small hospital; male or female; location — western New York; must drive car, minimal night work, no obstetrical coverage. Salary $6,000.00 to begin, increasing to $7,500.00 within two years. Must be well trained, alert, competent, and conscientious. Desire only such individual who takes pride and satisfaction in performing fine quality anesthesia. This is intended to be a permanent association in a small, friendly medical community; primary interest is in competence, conscientiousness, and reliability. Forward all details in first letter of age, sex, experience, photo, and letters of recommendation. This is not an urgent placement, and careful processing can be done. Write: Box M-39, Journal of the American Association of Nurse Anesthetists, 116 S. Michigan Avenue, Chicago 3, Illinois.

NURSE ANESTHETIST: 75-bed general hospital fully approved. $450 per month starting salary with annual increases. Full maintenance and other benefits. Modern, air-conditioned surgical suite. Complete details by writing or calling Administrator, Maria Parham Hospital, Henderson, North Carolina.

Openings now available for Nurse Anesthetists. Salary range: Present $4050-$5170; 1/1/57 $4185-$5485. 1000-bed public general, teaching hospital. Write Superintendent, Edward J. Meyer Memorial Hospital, 462 Grider Street, Buffalo 15, New York.

NURSE ANESTHETIST: 64 - bed general hospital. To be third anesthetist. Salary $450.00. Located in city of 12,000 near Sacramento. Must be member A.A.N.A. Apply: Anesthesia Department, Woodland Clinic Hospital, Woodland, California.

NURSE ANESTHETIST: Immediate opening. Salary commensurate with experience. 110 bed hospital, 40 miles south of Atlanta, J.C.A.H. approved. Anesthesiologist in charge of department. Send full information in first letter to Department of Anesthesiology, Griffin Spalding County Hospital, Griffin, Georgia.

NURSE ANESTHETIST. Starting experience. 110-bed hospital, 40 miles salary $415 per month for A.A.N.A. members, $380 per month if eligible for membership. Annual increases plus laundry and private room with bath and telephone in new women's residence. Social Security and Pension Plan. 40 hour week including full time credit for first call. Second call paid for cases done. Six paid holidays, 30 days vacation annually and liberal sick leave policy. Apply: Marshall Kerry, M.D., Chief Anesthesiologist, The Reading Hospital, Reading, Penn. 2

NURSE ANESTHETISTS: General voluntary hospital, 200 beds, opening February, in suburb New York City. Top working conditions and personnel policies. Apply: Administrator, Booth Memorial Hospital, Flushing, New York.

NURSE ANESTHETISTS (4): University hospital. Anesthesiologists and Nurse Anesthetists, large dept., all types of anesthesia, all benefits. Apply Anesthesiologist in charge.

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ANESTHESIOLOGY RESIDENCY 2 YEARS—400-bed Teaching Hospital, All types of surgery. Write: E. Stewart Owre, Director of Anesthesiology, Long Island College Hospital, 340 Henry Street, Brooklyn, New York.

NURSE ANESTHETIST — Modern 104-bed hospital. Good working conditions. Salary open. Write or phone collect: Mrs. Marjorie Dixon, Wesley Long Hospital, Greensboro, North Carolina.

WANTED: NURSE ANESTHETIST A.A.N.A. Membership. Excellent salary and opportunities. Paid vacation. Excellent working conditions. Rotating call every seventh night and seventh weekend. Day off following call; 550 bed hospital. Staff of nine anesthetists. Apartment and full maintenance available. Apply: Miss Mildred Hodges, Chief Anesthetist, Missouri Baptist Hospital, 919 N. Taylor Avenue, St. Louis, Missouri.

NURSE ANESTHETIST: Immedate opening for 2 anesthetists to complete a staff of 5 in a large group of 30 doctors. No obstetriral call. Paid vacations. Starting salary $450 - more with experience. Apply to the Personnel Director, Christie Clinic, Champaign, Illinois.

Legislation

(Continued from page 68)

leaving her unattended in the bathroom when she had such a short time before undergone an operation, the effects of which had not yet worn off, presented questions which should have been left to the jury. Defendant was bound to exercise such reasonable care toward plaintiff as her known condition required. The questions posed in this case should have been submitted to the jury. The judgment was reversed and the cause remanded for a new trial.

(Quinn v. P. & S. Hospital, 5 CCH Neg. Cases 2d 837 - Tenn.)

Monitor

(Continued from page 62)

way connection of the three-way stopcock is usually allowed for the heart sounds; to take blood pressure readings, merely turn the three-way stopcock. It is completely satisfactory for use in both adult and pediatric anesthesia.

Esther M. Momrow
Captain, USAF (NC)
Norton AFB, California

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